Employment and Immigration Canada
Emploi et Immigration Canada

ELECTRICAL AND ELECTRONICS MANUFACTURING INDUSTRY

Human Resources Study

Canadian Occupational
Projection System
(COPS)

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The strength of this report is based on the extent to which it reflects a consensus among the many industry, labour and government participants who contributed their time and resources to the study. Over 120 establishments responded to the extensive questionnaire that was used to collect quantitative information about the industry. In addition, a representative sample of interviews and focus groups were conducted with many companies across the country designed to address the issues from a qualitative standpoint. The depth of this study would not have been possible without the cooperation of these companies and their representatives.

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THE HUMAN RESOURCE IMPLICATIONS OF TECHNOLOGICAL CHANGE IN THE CANADIAN ELECTRICAL AND ELECTRONICS MANUFACTURING INDUSTRY

EXECUTIVE SUMMARY

The electrical and electronics industry in Canada is large and highly diversified. The industry includes makers of mature products such as consumer appliances, electrical transformers and lighting fixtures, as well as those in leading edge technologies involving aerospace and telecommunications. In 1984, electrical and electronics manufacturers employed 147,600 people and shipped $14.6 billion in goods. The sector's largest employers are multinationals employing thousands of workers. But the sector also includes hundreds of small specialized companies, some of which are growing at spectacular rates. Manufacturing methods differ considerably. These range from traditional manual assembly line production to highly automated manufacturing workstations. The industry, perhaps more than any other, is linked to almost every other sector of the economy serving consumer, industrial, commercial and government markets - both in Canada and around the world.

In many ways the industry is a microcosm of Canadian manufacturing. The new technologies are causing fundamental changes in the ways products are assembled and manufactured. These changes are redefining the occupational mix and the skills required throughout the work force. To some degree, these changes are being experienced by most Canadian manufacturers. What makes the industry unique is that it is both a supplier and a consumer of some of the technologies which are redefining the manufacturing process.

The industry has been experiencing a period of upheaval

A number of developments have contributed to a particularly difficult period for the industry in the recent past. Many companies have been facing increasing competition from offshore manufacturers. Competition and cost pressures have forced some companies to rationalize both nationally and

internationally creating painful adjustments in the sector. Layoffs of the work force have been commonplace. As a result of the industry's close relationship with other parts of the economy, markets dropped off considerably for many of the industry sectors during the 1981-82 global recession. The decline in construction hit many hard, as did recession in resource industries which affected many manufacturers in western Canada. Shorter product life-cycles caused by shifting consumer tastes and product innovation and diversification have introduced considerable volatility in some markets.

Total employment levels declined almost 14 percent between 1981 and 1983, and have yet to regain pre-recession highs. The reason for the slow rebound in employment is in part due to slow growth in markets. It is also due to an overriding emphasis on productivity - doing more with less is the name of the game. Business practices adopted to increase productivity such as rationalization, product advances, new production methods and new management techniques are creating a more competitive environment which in turn is increasing the need for firms to operate with the best possible efficiency and flexibility.

How the industry has reacted

The industry has reacted in a variety of ways. For some sectors, such as consumer electronics and telecommunications, change has been dramatic - for other mature sectors, such as electrical industrial equipment and lighting fixture manufacturers, change has been more incremental. The drive toward improved productivity is universal and perceived as essential for survival. Companies everywhere are also striving for improved product quality. Spurred by improved quality of products from overseas, an emphasis on product quality is necessary to remain competitive. Companies cannot afford to produce without high-quality components, and assembly must be performed to consistently high standards throughout the production process. Components and parts delivered to manufacturers must consistently be of high quality since many are adopting just-in-time inventory management systems and a defective part could cause expensive interruptions in production. Further, quality can sometimes be

critical since human lives may depend on the proper functioning of certain products manufactured by the industry.

Shorter product life-cycles now require that pay-backs on many new products be within a short period. Increased product diversification and shorter product life-cycles mean producers must react quickly to changes in market conditions. The lead times in setting up production and the runs themselves are shorter than several years ago. Research and development to find the niches and develop new products are receiving a new emphasis even in mature sectors of the industry.

To maintain or increase sales, many in the industry are increasingly turning to export markets. Some large companies have received international product mandates from their parent organizations which have formalized their export strategies.

Some companies have established separate service and maintenance operations which they see as a growing market opportunity both for the servicing of their own and their competitors' products.

The future looks encouraging, but planning is difficult

The competitiveness of the market, with many new and changing products and processes is creating a volatile operating environment for many producers of electrical and electronic equipment. This fast and rapidly changing environment is becoming a permanent characteristic of the industry. As a result, planning is more difficult and many of the firms interviewed have difficulty projecting their own business plans and employment requirements more than two years in the future. While some sectors expect to see strong growth in sales over the next five years and others are trying to maintain their current position, most do expect sales increases.

Growth in employment will be slow at best - volatility in the labour market will continue

Many companies believe that the elimination of surplus employees has been accomplished to a large degree. Large increases in employment are not expected as sales rise in the future. Greater uncertainty in the long-term market prospects for many products is now commonplace. Volatility in the labour market unfortunately will be the norm. Job security at all levels will be an increasingly fragile concept. Employees in all sectors of the industry, including those on the leading edge, are uncertain of their prospects even two or three years down the road. For some industries, layoffs and recalls have become a common strategy in meeting the vagaries of market demand for their products.

The mutually reinforcing drive toward improvements in productivity and product quality are forcing manufacturers to adopt the new technologies throughout the organization. The result is better quality with fewer workers. Even where sales and market growth are buoyant, the productivity imperative means that employment is likely to grow slowly at best.

Changing technology has had a dramatic effect on the kinds of jobs people do. The introduction of new technologies at some companies has considerably reduced employment levels. For others in some of the more mature sectors of this industry, technology may have had little impact on job skills or employment levels. Most companies reported that market developments and the resultant industry reactions, such as layoffs, acquisitions and mergers, reduced employment levels much more dramatically than the adoption of new technologies. In this respect, technology has tended to be evolutionary rather than revolutionary in its application and its impact on employment.

The adoption rates vary across technologies

The need to adopt new technologies has been driven mainly by the needs to improve speed, product quality, and productivity, in order to improve the industry's ability to remain competitive, both domestically and internationally. The adoption of the technologies mentioned in this report has been uneven across both the sectors and the different company size groups in the industry.

The survey results indicate that the most widely adopted technologies in the electrical and electronics industry by 1990 will be microcomputers, computerized financial systems and order entry/inventory control, and the combination of material requirements and manufacturing resources planning. This implies that computerized administration appears to be the initial focus for technological change for most of the industry. Contrary to this, though, is the fact that computer links between head offices and their divisions, as well as with suppliers and customers, do not enjoy very wide usage.

There has been relatively rapid adoption of computer-aided design since 1983, but none of the other design technologies are being implemented to a large degree. Similarly, the pace has picked up for the work organization technologies such as self-managing work groups, leading to a certain degree of organizational innovation.

The rates for 'hard' technologies, such as robots, have been relatively steady but not very rapid. Companies perceive these as becoming more prevalent in the long term, between 5 and 20 years, which is outside the range of the survey sample. The process technologies, such as statistical process control and quick tool and die change, experience the lowest levels of adoption and interest does not appear high to change this in the future.

It is apparent from the survey results that the rate of initial adoption of new technologies is slowing. This may indicate that firms that are most likely to begin using a new technology have already done so. But it is also quite likely that there is a great deal of uncertainty in the industry and companies are unable to forecast their technological requirements, even for the few years before the end of the decade.

Technology is changing the skills people need

There has been an evolution in generations of technology from electromechanical technologies to electronics. This evolution has created the need for different occupational and skill requirements. For example, the new

production technologies are changing the traditional demarcations between designers and tool makers as well as performing some of the machine set-up tasks. This has led to a perception among many workers that machines have led to 'down-skilling' of some of their traditional 'hands-on' work and replaced it with work which is more of a monitoring and controlling function.

While having to do less craftsmanship work, these line workers are being called upon to be more analytical. Because of the need to have short production runs with a minimum of product rework, they are being required to perform a wider variety of tasks and become more responsible for the quality of their own work. Thus the trend towards 'down-skilling' and 'multi-skilling' is coinciding with the need for employees to be more flexible, analytical and capable of solving problems as these arise. The operation of machines is increasingly requiring some basic literacy and the understanding of simple mathematics.

There may be a need for fewer unskilled, semi-skilled and administrative workers since these are the ones most exposed to displacement caused by the introduction of new technologies. There will be a greater need for technical, design, engineering, sales and marketing employees in order for companies to respond quickly to changing market opportunities. There will also be a need for skilled service and maintenance personnel to diagnose and solve problems as they occur.

Most companies attempt to retain and retrain their existing employees when introducing new technologies. However, many workers are uncertain about the impacts of the technologies and the long-term future of the organization. To combat this uncertainty, workers see improved employer and employee communications and better training methods as the best ways of increasing productivity, cost efficiency and morale. Employee suggestions can bring dramatic product and process improvements, while more consistent contact with management lessens the shock of layoffs and cutbacks. However, some companies who have older work forces have said that older workers have greater difficulty adjusting to change due to their seniority, tradition, and education level and may question whether it is really worth learning new technologies at their age.

New office technologies are also creating the need to have computer and keyboard literate office personnel. Poor implementation of these technologies can cause resistance and negate the productivity improvements they are intended to produce.

The organization of work is changing

New technologies are changing the meaning of traditional job descriptions and blurring the traditional boundaries between jobs. In some situations, management's attempts to redefine or reduce the number of job descriptions have been resisted since they were perceived as strategies to reduce the compensation levels of line employees.

Responsibility for quality control and production management is increasingly being passed to the individual workstation. Examples of these decentralized forms of work organization include self-managed work groups, quality-of-working-life programs and quality circles. These are being developed to facilitate flexibility of production and to improve productivity by encouraging employees to become more responsible for control and monitoring of the production process and the diagnosis of problems on the shop floor. This is tending to flatten company hierarchies. As a result, companies are giving increasing attention to new ways of motivating workers given that many of the traditional avenues such as advancement in the corporate hierarchy will be less readily available.

Although small businesses may lag behind in the adoption of new technological production methods, they are quicker to use improved human resource management techniques. Examples such as decentralized forms of work management and organization are relatively inexpensive to adopt but very effective in improving productivity. These benefits are available to larger firms if they can overcome their typically more complicated and less flexible management structure.

Human resource management is becoming increasingly important

Spurred by the rapid developments over the past five years, human resources planning is only now becoming a common practice in the industry. While personnel departments existed before, many firms have upgraded their status by bringing in more skilled human resource professionals. Human resources appears to be evolving from an administrative function to a management function. The volatile business environment, while making planning more difficult, has increased the need to plan. Gaining familiarity with possible future business developments ensures smoother adjustments than simply a 'wait and see' planning attitude.

Educational institutions and industry must respond to the new training challenge

The longer term need for new entrants to the industry is a concern to employers. Many firms are satisfied with the quality and skills of people emerging from community colleges and universities. However, because of the increasing emphasis on multi-skilling and the need for more analytical and communication skills, companies generally want people with better basics in literacy and numeric skills.

Given that many companies are increasingly emphasizing the role of research and development, some companies felt that there should be a much stronger symbiotic relationship between industry and the research capabilities of the universities. Educational institutions are not seen as being at the leading edge of technological development.

Increased and better training is seen by companies as an integral part of their long-term success, but this attitude is by no means universal. Short term on-the-job training is the main way in which companies see their immediate needs being met with their existing work force. Most employees also appear willing to learn the new technologies. Employees take an active interest in the success of their company and are willing to help where possible. However, the recent past has left many with feelings of uncertainty about their own futures.

The need to provide appropriate skills training is imperative given the changing technological environment affecting the industry. This applies to all employees in the organization. The industry will probably never again experience the relatively stable period of the 1960s and 1970s. While there have always been fluctuations in production, companies feel that the disruption of the early 1980s was unlike other periods experienced by the industry. The competitive forces which led to the instability in the industry are not about to subside.

Possible job displacement by these technologies will no doubt be a part of the industry as it is in other industry sectors. However, there is little alternative. To ensure continued vitality and viability, the industry must continue to adopt new technologies and provide appropriate training. Training and the adoption of these technologies from this perspective must be seen as an investment in survival rather than a cost of doing business.

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CONCLUSIONS

The long-term survival of the electrical and electronics industry in Canada will depend on the ability of the industry to attain and remain competitive in the international marketplace. Competitiveness in this industry implies the need to aggressively adopt and adapt leading-edge technologies, particularly in the electronics sector of the industry and, at the same time, to manufacture products in the most efficient and cost-effective way possible. Such a challenge implies the need for consistently high levels of expenditure in research and development activities, more intense competition in not just the Canadian but the international marketplace, and a continuing emphasis on raising productivity throughout the industry. Successfully meeting the challenge can only be accomplished with a highly trained and flexible work force.

Many in the industry believe that there is a need for a national industrial strategy to focus all of the necessary resources of government, industry and labour on the long-term economic success of the electrical and electronics industry and other industries deemed vital to Canada's future well-being. This study does not consider in any detail the merits of such a consensus, but our discussions have shown that many within the industry believe that developments over the next ten years will be critical to the future of the electrical and electronics manufacturing industry in Canada. They believe the involvement of government, industry, labour and educators is necessary to raise the profile of the challenge and to ensure that the appropriate effort is directed towards meeting the industry's needs. Addressing the skills and training requirements of the industry is thus a vital part of this long-term challenge.

Many in Canada perceive that the industry and its 'high technology' is the wave of tomorrow. Associated with this belief is the hope that as this industry grows, it will provide the wealth and jobs which will replace declines experienced in other more mature industries. Unfortunately, the industry outlook suggests that this is far from reality. The paradox is that as the industry generates wealth, productivity improvements will continue to displace jobs. The outlook is for slow employment growth at best and the volatile pattern

of layoffs and recalls experienced in the recent past are likely to become more commonplace.

The implications for the industry, government and individuals are profound. For the individual, traditional values about the way people are educated, gain and maintain employment, and choose a community to live in will require fundamental examination. Clearly, long-term secure employment with a company is no longer taken for granted. Individuals will need to become increasingly entrepreneurial in their career outlook and personal orientation.

For government and the industry, problems are presented which, while not new, will become more prevalent. Many of these problems will likely be shared by other industries and will therefore be national in scope. How to train people who are unemployed, how to retrain older workers in the new technologies, and how to assist in relocating displaced employees into other jobs, other industry sectors and other communities are some examples of these national problems. Those responsible for the formulation of public policy will become confronted with the uncomfortable issue of whether they can encourage support of an industry sector which promises to create wealth but minimal employment generation prospects.

The industry is not currently facing major shortages of workers in specialized trades and occupations as it once did in the past. Neither is there an overriding single issue or 'quick fix' which is needed to meet the human resources needs of the next decade. We have found, however, that a number of key issues now face the industry and government policy-makers:

- The industry and government must encourage investment in both capital equipment and training in the new technologies in order to remain competitive in an international environment.

- New entrants into the work force must be equipped with all the basic skills required for companies to train them as quickly as possible. New entrants include those leaving both the secondary and post-secondary educational levels.

- Existing skills of those now employed in the industry must be upgraded as a result of the introduction of new technologies, changing work organization and changing responsibilities.

- The industry and government will increasingly have to address the problems created by labour adjustments and layoffs. Those displaced by the industry will have to be retrained for jobs in the industry or in other manufacturing or service sectors. This could be a major problem since the electrical and electronics industry is one of the most successful in Canadian manufacturing and other manufacturing sectors may face even worse prospects for job creation and retention of employees.

The long-term adaptability of the work force will be affected by the skills and education of the new entrants and the retraining and skills upgrading of the existing force. The Electrical and Electronic Manufacturers Association of Canada (EEMAC), as the representative of the electrical and electronics industry, has already made public its own recommendations for change in the area of post-secondary education. These recommendations call for provincial governments and academic institutions to raise the quality and standards of education, together with the need to introduce specific measures into the educational system. The industry's position, as presented to the Senate standing committee on National Finance, and in other background papers, is summarized below.

- Provincial governments and the governing boards of academic institutions must develop a strategic plan of action. The objective of this plan would be to raise the standards and quality of education and to restore adaptability to the education system. EEMAC believes that funding at the post-secondary level should be increased, primarily by redirecting funds assigned to primary and secondary education.

- Key elements of the strategic plan are to:

    - Introduce uniform high school graduation standards that require basic credits in mathematics and science.

    - Establish core requirements in post-secondary educational institutions for arts, humanities, science and technology to ensure that technologically literate people graduate, regardless of specialization.

- Establish boards of governors within post-secondary institutions who are fully and firmly responsible for their institutions and whose membership is strong and energetic in their tasks.

- Move to a more market-driven system of revenue generation giving more scope for funding and influence by the federal government.

- Establish a portion of strategic funding which would permit the deliberate re-allocation of resources for strategic purposes as the need arises.

- Provide a means for increasing the rate of turnover of existing faculty and for re-establishing a more balanced age distribution within faculties of post-secondary institutions.

It was not an objective of this study to address ways of increasing capital investments in the new technologies although clearly this will be critical in keeping the industry competitive, nor was it an objective to recommend specific changes to the funding or positioning of science and technology within Canada's educational system. However, our work has clearly shown that as automation, computers and electronic controls become more common place, so too does the demand for individuals with fundamental education in subjects such as mathematics, computers and other basic skills. There is a clear trend in the work place towards greater skills which are more 'diagnostic' in nature than 'hands-on', particularly in the case of new production technologies.

There is also cause for concern by many employers that universities and colleges are no longer at the leading edge of technology and that students at the graduate level are not up-to-date by the time they enter industry.

On the key issue of upgrading and training the industry's work force, we found that many companies, particularly the larger ones, have already introduced and trained many of their employees in response to the adoption of new technology. Almost all companies regard the training challenge they face as being one which only they can define and implement. The following recommendations are directions which industry has put forward in order to better address the issue of retraining and skills upgrading.

- Despite the increasing difficulty of conventional long-term forecasting in the industry, there is a need for the industry to plan its long-term strategy for survival. Human resources are part of the investment necessary for long-term survival.

- The industry needs to continually develop and monitor its skills and training needs in order to keep pace with technology, productivity and other forces which are driving the need for changing skills.

- Skills upgrading and retraining requirements need the full support of government, employers, employees and their unions. Employers and unions need to actively encourage employees to develop and enhance their skills when necessary.

- Government policy should increasingly be aimed at encouraging employed workers to stay up-to-date and upgrade their skills. Government should, however, retain traditional support for unemployed workers.

- Government programs and funding to help the training needs of industry should increasingly focus on skills upgrading. Individual companies and their unions are the ones to identify specific training and the upgrading of skills required and, as such, any government funding or assistance on training programs should be controlled by the recipient company.

- Many mature workers in the industry face the need for retraining. In many situations, this may involve the need for longer-term as well as short-term training in order for such workers to acquire the basic educational skills necessary to cope with a changing work environment. The industry needs to discuss with unions, government and educational institutions how best to address the upgrading and retraining needs of older workers.

- The industry needs to encourage more interaction between academic staff from community colleges, universities and companies with the appropriate representatives from the electrical and electronics industry. Academics need regular interaction with the industry in order to stay current with its changing needs.

- The industry should work with community colleges, universities and government to help them implement a wide variety of on-the-job co-operative training programs. These may include traditional apprenticeship style training or co-operative education programs which involve alternating periods of employer-sponsored on-the-job training and training in educational institutions. In turn, the industry and unions must be prepared to support these programs.

- The industry should consider ways and means of encouraging and directing companies who face the need to upgrade or redirect the skills of its work force. A data base of specific training already conducted by member companies could, for example, help those firms who have identified a need for training to quickly find the colleges, companies and individuals who could conduct the training or provide assistance. In Ontario, such a data base could fit within the objectives of the new Institute for Skills Training of the Ministry of Skills Development.

There will not be easy solutions to the problems of layoffs and the labour adjustment process. Clearly, the nature of the problem is likely to be different depending on the expected duration of the layoff, the location of the layoff, the age of the individual affected, the prospects of finding alternative suitable employment, or whether the individuals are the primary or secondary household wage earners.

- The industry, government and the unions must develop a variety of approaches to address the problem of layoffs and the need to retrain workers. These approaches must address the issues of physical and financial access to training and access to jobs either in the same industry sector, alternative industry sectors or in other communities. Pension reform, which encourages labour mobility, is a positive step in this process.

To be successful, these directions need the full commitment and support of all those involved - employers, employees and their representatives, and the government at both the federal and provincial levels. There is a clear need for good communication between these groups in order to alleviate the many fears that can arise due to change.

1. BACKGROUND, OBJECTIVES AND METHODOLOGY

1.1 Background and Objectives

This Human Resource Study of the Electrical and Electronics Manufacturing Sector has been compiled with the primary objective of examining the impact of changing technologies on the industry and to evaluate and anticipate employment and skill implications. The study was undertaken jointly by the Electrical and Electronic Manufacturers Association of Canada (EEMAC), the Communications and Electrical Workers of Canada (CWC), the International Brotherhood of Electrical Workers (IBEW), and the Employment and Immigration Commission (EIC). The study was to provide participants with information which will be used in developing policies and priorities for human resource development in the industry. A fundamental concern to the participants was an observed decline in employment in the industry sector, with the total work force falling almost 14 percent from 161,900 in 1981 to about 140,000 in 1983. Although the industry employment level has since expanded, it remains below the 1981 peak.

The specific study objectives were as follows:

1) To identify technological and market developments and the nature of their effects on the sector's occupational requirements and supply;

2) To draw human resource planning/adjustment implications from these;

3) To assess aggregate employment effects of these changes over the next 5 years; and,

4) To identify training/adjustment needs based on the analysis.

The study has been organized into a series of modules as follows:

1) Industry Profile and Employment Outlook. The objective of this module was to identify the competitive and structural changes taking place in the sector, the impacts of these trends on companies and their implications for employment in the industry.

2) The New Technologies. This module examined the major technologies having an impact on both office and production skills and their impacts on employment and skills requirements.

3) Changes in Skill Requirements and Occupational Profile. This module reviewed the effects of market pressures and technological changes on this industry's occupational structure. It also provided a review of the sources of supply in each occupation.

4) Adjustment Patterns in the Industry. The objective of this module was to examine what happens to workers who have been displaced from their jobs as a result of the market or technological pressures.

5) Human Resource Planning Implications. This module provided an assimilation of the information and data from the study and an analysis of the employment situation and outlook in the industry.

Our objective was to review the major sectors of the industry and to identify those trends which characterize the industry. The study was not intended to be an exhaustive analysis of the industry on a sector by sector basis - although there are clearly specific situations and challenges which affect one sector of the industry more than others.

1.2 Methodology

The study approach included a number of components:

1) A detailed questionnaire survey was mailed to a sample of companies in the electrical and electronics manufacturing industry sectors. The objective of the questionnaire was to obtain a snapshot of the state of the industry, the current and projected use of technology and an estimate of future employment and training needs. This questionnaire was administered by EIC and was reviewed by the Steering Committee prior to being sent out to the industry. The survey instrument addressed a number of issues regarding impacts of technologies on human resources; it was especially designed to obtain quantitative information of industry trends including estimates of future employment requirements at a detailed level. A more detailed description of the survey methodology and coverage is included in Appendix I.

2) Personal interviews were conducted by Woods Gordon and EIC with senior representatives of companies across Canada. Companies were selected to include a random coverage of each of the sectors. A number of interviews were also conducted with large employers and companies across Canada to obtain a regional perspective. Persons interviewed were usually the senior individual responsible for marketing or operations. These interviews were conducted on-site and in many instances included more than one executive with each company.

3) Focus groups were conducted by Woods Gordon with employees in individual companies representing different sectors. Companies were selected after the initial interview in order to gain an understanding of each company's recent work history. Companies were chosen for focus groups to reflect a combination of circumstances which appeared to be of interest or typical of the pattern in the sector as a whole. For example, companies selected may have recently had a significant layoff or were adapting to new technological developments. Participants in the focus groups were chosen to include primarily production employees since these employees had been most directly affected by technological and other changes. In some cases, separate focus groups were conducted with production workers and with their supervisors.

2. INDUSTRY STRUCTURE AND CHARACTERISTICS

The electrical and electronics industry is highly diversified. It includes leading edge organizations in communications, electronics and instrumentation technologies, as well as older firms with mature technologies such as electrical transformer and lamp manufacturing. According to the 1984 Census of Manufacturers, the industry employed 147,600 people and shipped more than $14.6 billion worth of goods from 1,572 plants and establishments. Most of the industry is geared toward the industrial and commercial markets. Almost 80 percent of shipments are accounted for by manufacturers of office, store and business machines, electrical industrial equipment, communications, wire and cable, scientific instruments and miscellaneous products. The consumer market, which includes small and major appliances, lighting fixtures, and radio and television manufacturers, accounts for the remaining 20 percent of shipments.

Growth in industry employment and shipments was strong in the 1978 to 1981 period, due mainly to the communications and office equipment sectors. However, slumping sales in 1982 and 1983 forced employment down significantly from the 1981 peak, displacing over 15,000 jobs. As conditions improved in 1984, the volume of shipments rebounded 12 percent and employment expanded a modest but respectable 5.7 percent, representing approximately 8,000 jobs. A summary of the industry's principal statistics are presented in Table 2.1.

The industry includes very large Canadian, U.S. and other multinationals as well as a large number of small and medium sized companies. Although establishments or their head offices are located mainly in Ontario, home of more than 50 percent of the manufacturing plants, the industry is a major contributor to most provincial economies. Products from the electrical and electronics industry are used by all sectors of the Canadian economy and, as such, the industry tends to follow the trends and cycles of the total economy.

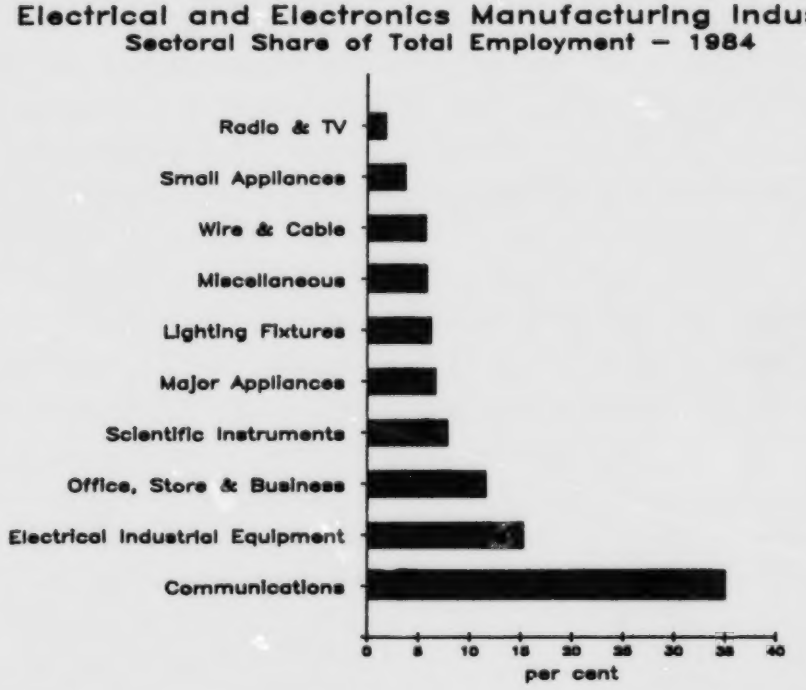
Table 2.1

PRINCIPAL STATISTICS

Electrical and Electronics Manufacturing Industry		1978	1979	1980	1981	1982	1982*	1983	1984
Establishments	number	1266	1414	1452	1510	1537	na	1429	1527
Employment	number	139060	147817	152830	161897	152285	144847	139668	147591
	%ch		6.3	3.4	5.9	-5.9		-3.6	5.7
Shipments	$m	8172.4	10125.9	11695.8	13531.6	13572.7	12614.1	12652.7	14641.8
	%ch		23.9	15.5	15.7	0.3		0.3	15.7
Industry Selling Price Index	1981=100	77.1	84.6	93.0	100.0	106.6	106.6	110.1	113.7
	%ch		9.8	9.9	7.5	6.6		3.3	3.3
Real Shipments	1981$m	10603.3	11964.3	12572.2	13531.6	12735.0	11835.5	11490.7	12878.0
	%ch		12.8	5.1	7.6	-5.9		-2.9	12.1
Real Shipments per employee	1981$000's	76.2	80.9	82.3	83.6	83.6	81.7	82.3	87.3
	%ch		6.2	1.6	1.6	0.1		0.7	6.1

* 1982 is repeated due to SIC revisions (see Appendix II)
Source: Statistics Canada, Census of Manufacturers

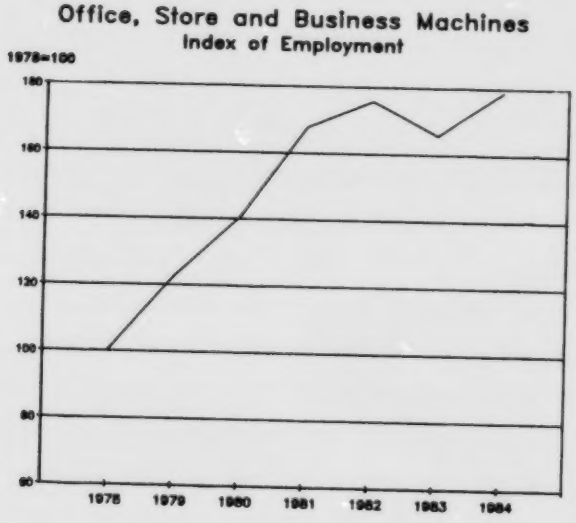
The figure below illustrates the composition of the electrical and electronics industry by sector on a shares basis.



The following discussion is a brief performance summary of the major components of the Canadian electrical and electronics manufacturing industry between 1978 and 1984 (the most recent year for which data are available) according to the Census of Manufacturers. For each sector identified, a chart is presented to show the path of employment and productivity (in index form) over the period. Corresponding tabular data and an explanation of the SIC system are presented in Appendix II.

2.1 Office, Store and Business Machines

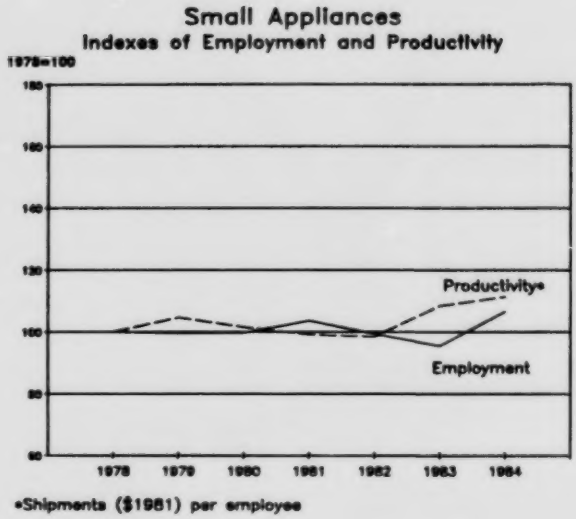
The office, store and business machines sector consists of firms engaged in the manufacture of cash registers, adding machines, word processors, photocopiers, typewriters and computers. In 1984 the sector employed over 17,000 people and shipped $2.3 billion in goods and services. Growth in this sector was very strong between 1978 and 1984, tripling the value of shipments and doubling the number of establishments. As seen in the chart, employment growth was also vigorous, except for a brief lapse in 1983, expanding at an average rate of 10 percent over the 1978 to 1984 period.



2.2 Small Electrical Appliances

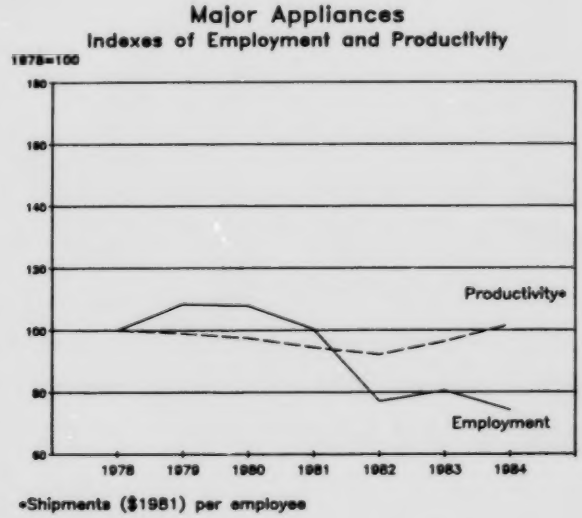
The small electrical appliance sector consists of firms engaged primarily in the manufacture of kitchen, household and personal care products. In 1984 the sector employed 5,500 people and shipped almost $700 million in goods and services. This sector showed unsteady and only marginal growth during the

1978-84 period. Performance was weak in the early 1980s, reflected by a decline in the volume of shipments of 6.2 percent between 1979 and 1982. Employment remained roughly constant over that period but productivity (defined here as constant 1981 dollar shipments per employee) declined markedly. Major gains occurred in total shipments and employment in 1984, due mainly to the recovery in consumer spending. At the same time, a number of manufacturing establishments were closed.

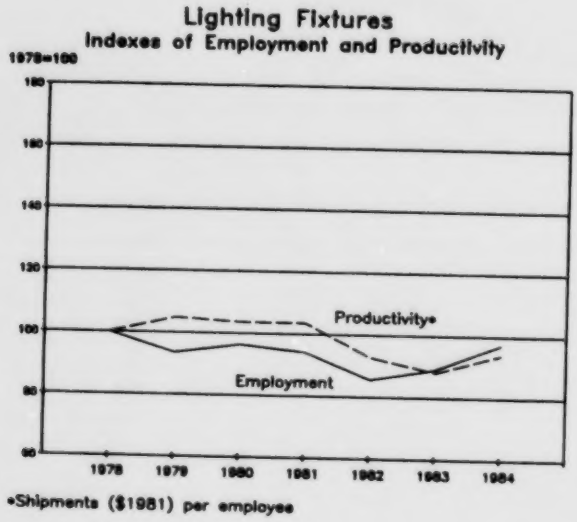


2.3 Major Appliances

The major appliances sector consists of firms engaged primarily in the manufacture of dryers, washers, refrigerators, freezers and ranges. In 1984 the sector employed 9,900 people and shipped almost $990 million in goods and services. Performance in this sector was the poorest relative to the industry as a whole over this period. After falling steadily in 1980 and 1981, plunging consumer demand pushed real shipments down a further 25 percent in 1982, generating a 23 percent cutback in employment and forcing a large number of firms to shut down or consolidate. By 1983, although a rebound had begun, employment and shipment levels remained far below previous peaks. At present only three large companies with several plants and divisions operate in this sector, down from 10 companies a decade ago.



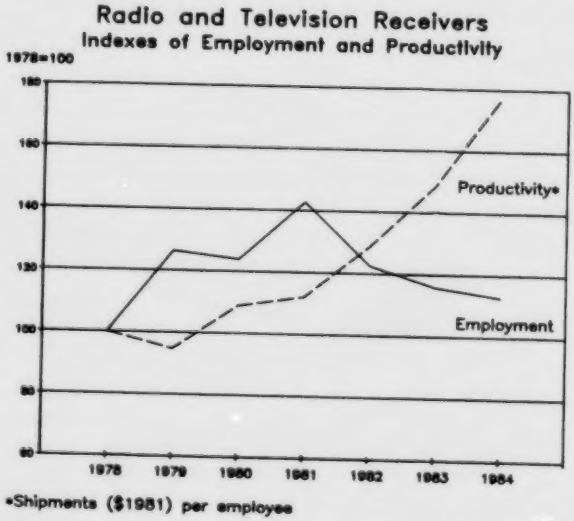
2.4 Lighting Fixtures



The lighting fixtures sector consists of firms engaged primarily in the manufacture of residential and industrial incandescent and fluorescent lighting fixtures. In 1984 the sector employed 9,200 people and shipped almost $980 million in goods and services. Gains in employment and real shipments in 1984, however, did not make up for the losses observed during the early 1980s.

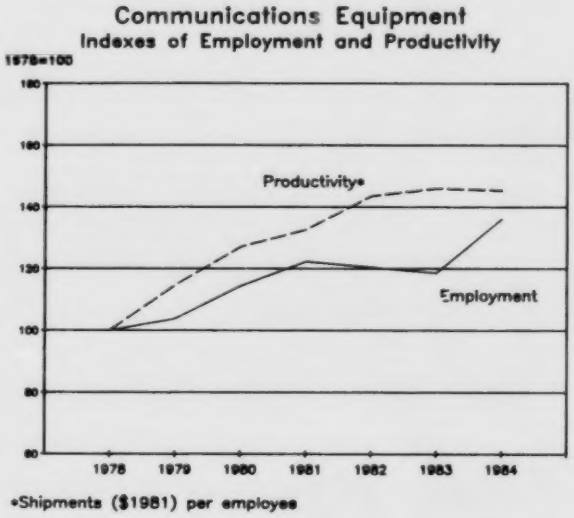
2.5 Record Player, Radio and Television Receivers

The record player, radio and television sector is the smallest group in the electrical and electronics industry in terms of both employment and shipments. The sector consists of firms engaged in the manufacture of record players, radios, television sets, tape players, recording equipment and components. In 1984 the sector employed over 2,600 people and shipped almost $600 million in goods and services. Rationalization has produced a consistent erosion in the number employed in this sector. The number of plants fell from 22 in 1979 to 16 in 1984 and employment fell from a peak of 3,300 in 1981. Productivity and shipments growth, by comparison, have been very strong. Modest prices and strong consumer demand for home entertainment equipment pushed the volume of shipments up an average of 12 percent per year between 1978 and 1984. Productivity growth averaged 10 percent per year over the same period.

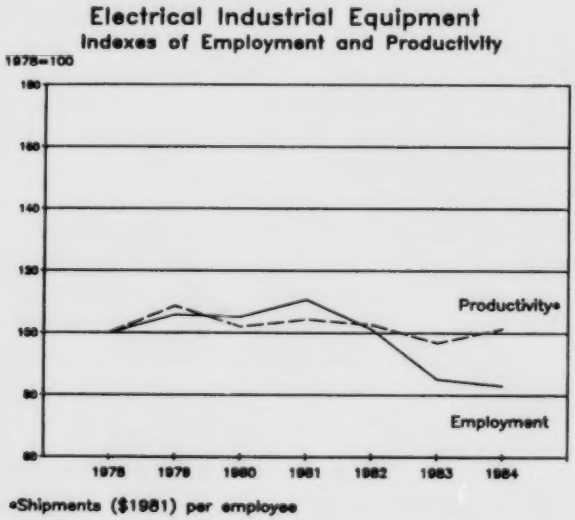


2.6 Communications Equipment

The communications equipment sector is the largest in the Canadian electrical and electronics industry and consists of firms engaged primarily in the manufacture of telephones, radio/satellite transmitters and receivers, semiconductors, integrate and printed circuits, and other data transmission products. In 1984 the industry employed almost 52,000 people and shipped $4.3 billion in goods and services. The 1982 recession had a negative effect on this industry, but the volume of shipments continued to rise throughout the 1978-84 period. Employment fell 3 percent between 1981 and 1983 before resuming strong growth in 1984. Productivity growth has also been significant in this sector.



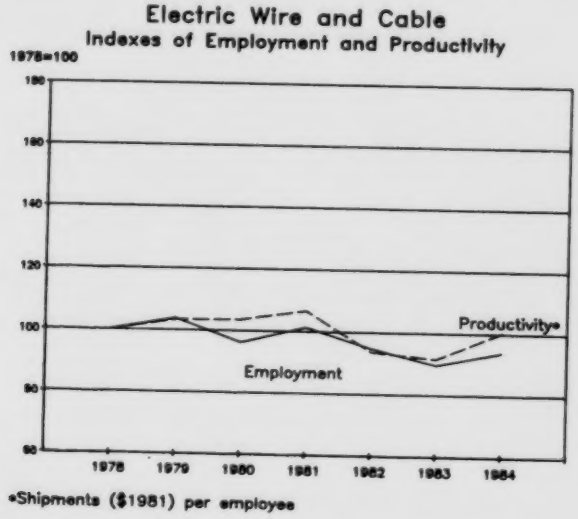
2.7 Electrical Industrial Equipment



The electrical industrial equipment sector consists of firms engaged primarily in the manufacture of transformers, motors, switchgear and control equipment. In 1984 the industry employed almost 23,000 people and shipped $1.9 billion in goods and services. This sector experienced a large slowdown in sales in the 1982-84 period due to weak construction activity. Real shipments declined more than 27 percent and almost 5,000 jobs were lost during this period.

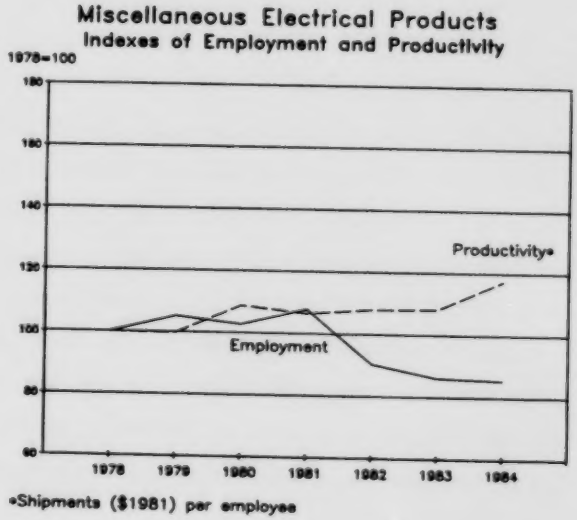
2.8 Electric Wire and Cable

The electric wire and cable sector consists of firms engaged primarily in the manufacture of electric wire and cable, both insulated and uninsulated, for telephone and telegraph systems, building construction, electrical power transmission and distribution, communication, and for other electrical equipment such as generators, transformers, motors and control equipment. In 1984 the industry employed almost 8,500 people and shipped $1.3 billion in goods and services. This industry had to deal with the decline in construction and machinery investment in the early 1980s, and sales declined farther than in other industrial market based electrical industries. After a very weak 1982 and 1983, shipments and employment increased dramatically, due particularly to strong demand from the U.S.



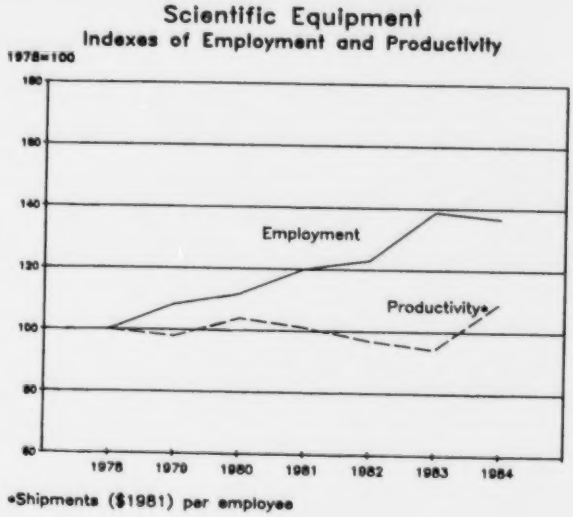
2.9 Miscellaneous Electrical Products

The miscellaneous electrical products sector consists mainly of firms engaged in the manufacture of batteries, metal switchboxes and panels. In 1984 the industry employed almost 8,700 people and shipped $950 million in goods and services. Employment was very weak in this sector, falling 22 percent between 1981 and 1984. Real shipments suffered a major decline in 1982 and 1983, but strong growth was once again restored in 1984.



2.10 Scientific Equipment

The study focused on the indicating, recording and controlling instruments sub-group of this sector, which includes firms engaged in the manufacture of temperature instruments, flow and level meters, indicating, recording and controlling devices and valves, and other scientific and professional equipment. Not all of the products in the instrument sector can be defined as electrical or electronic, but it is not possible to disaggregate the total. In 1984 the instrument sub-group employed about 11,600 people and shipped $700 million in goods and services.



2.11 Related Activities

There are several types of activities related to electrical and electronics manufacturing that are spin-offs of various industry processes or products. These activities are not classified specifically into the manufacturing category and will be referred to from this point on as 'service' establishments. An attempt to cover this area in the proper amount of detail would have required a separate study, but it is too important to omit altogether. To capture this natural extension of the industry briefly, four types of service companies were interviewed to provide an overview of employment, occupation and market trends. The types of services focused on were: telephony, which refers to integrated telephone systems for both small and large companies; environmental control systems, which includes integrated temperature and ventilation systems in commercial and industrial buildings; repairs of home entertainment equipment, such as radios, televisions and stereos; and security systems, for residential, commercial and industrial customers. Detailed quantitative information is not available due to the selective nature of the specific services chosen, but general information and findings will be provided at different points throughout this report.

3. INDUSTRY AND EMPLOYMENT OVERVIEW

3.1 An Overview of Trends in the Industry

As in many well developed industries, conditions over the past five years have brought about profound changes in the way electrical and electronics industry does business. The 1981-82 recession in North America was the longest and most severe downturn since the depression of the early 1930s. Technological advances have steadily accelerated, creating many opportunities for the industry and, at the same time, creating more adjustment and planning problems.

Since the recession in 1982, sales have been picking up for some sectors although employment growth in the total industry continues to be slow. In addition to the recession, other trends which have affected the Canadian electrical and electronics manufacturing industry include increasing international competition and increasing domestic and international rationalization.

3.1.1 The 1981-82 Recession

The 1981-82 recession caused numerous plant closures and layoffs. Almost all sectors were affected in some way, some dramatically. Employment in the entire industry declined almost 10 percent. Major appliance and wire and cable manufacturers were particularly hard hit. Shipments in these sectors dropped 15 percent between 1981 and 1982. Only small appliance and communication equipment industries managed to increase shipments in this period.

While the recession affected most companies serving both the industrial and consumer marketplace, the exact timing varied somewhat. Appliance and home entertainment equipment manufacturers suffered because of the downturn in consumer spending. The consumer sector, however, was quick to turn around as a result of the economic recovery in early 1983. By contrast, suppliers to industrial markets were affected by the very weak capital investment and

building environment through the entire 1982-84 period. Due to dependence on the industrial and commercial sectors by much of this industry, the low point in both industry shipments and in employment came in 1983, a year later than for the economy as a whole.

Other sectors, such as scientific instruments manufacturers which produce many products destined for the resource industries such as petroleum and forestry, also suffered due to the downturn in activity in these industries. Companies in western Canada, geared mainly for the local market, were particularly hard hit by this trend.

Those companies least affected by the recession tended to be those serving special needs such as defence and some companies in telecommunications. Some smaller companies producing highly specialized products grew during this period, however, these companies tended to be the exception to the trend experienced by the industry as a whole.

3.1.2 Canada in the International Marketplace

Although the electrical and electronics industry is a major contributor to Canada's manufacturing sector, it is relatively small in comparison with the world market. The industry in the U.S. ships in excess of C$400 billion in electrical and electronics products, more than 20-times the amount shipped by Canadian producers. The sector in Canada is vitally dependent on the export markets, particularly the U.S., which absorbs three-quarters of Canada's exports in this sector. Of the $15 billion in industry shipments in Canada in 1984, roughly $4 billion in products were sent to the U.S. While the value accounts for a significant amount of Canadian production, it is small in relation to the U.S. market. Imports account for roughly 10 percent of the U.S. demand for electrical and electronic products, or about C$40 billion. Pacific rim countries account for over 70 percent of U.S. imports, while the Canadian share is close to 10 percent.

Table 3.1 below is included to help lend an international perspective to Canada's position in the electrical and electronics industry. The three major players - the U.S., the EEC (10 Countries of the European Economic Community), and Japan - accounted for over 85 percent of the Canadian electrical and electronics industry's exports and 90 percent of its imports in 1985. The U.S. is becoming a more dominant market for Canadian producers, absorbing 90 percent of Canada's exports to these three markets in 1985, up from 79 percent in 1975. This is mirrored by a decline in the share of exports to the EEC over the same period.

Table 3.1

Canadian Electrical and Electronics Industry
Exports and Imports

	Japan		U.S.		EEC		Other	
EXPORTS	$current	$1971	$current	$1971	$current	$1971	$current	$1971
1975	25.3	18.5	552.7	405.8	123.2	90.5	307.1	225.5
1980	35.3	18.6	1760.1	928.8	357.4	188.6	639.2	337.3
1985	56.5	23.7	4619.5	1935.3	422.6	177.1	874.1	366.2
IMPORTS								
1975	250.9	184.3	2008.3	1474.5	313.1	229.8	164.0	120.4
1980	562.8	297.0	5109.8	2696.5	396.2	209.1	481.5	254.1
1985	1529.5	640.7	9075.1	3801.9	673.1	281.9	1152.6	482.9

Source: Current dollar figures from Department of Regional Industrial Expansion

The table also shows that Canada's exports to Japan for this industry have increased by only 27 percent between 1975 and 1985 (in constant $1971), while imports from Japan have more than tripled. Japan's share of the electrical and electronics imports to Canada from these three markets has risen from 9.7 percent in 1975 to 13.6 percent in 1985. In contrast, Canada has made net gains in trade with the U.S. in the last 10 years. The proportion of exports to imports between Canada and the U.S. has risen from 27.5 percent in 1975 to 51

percent in 1985, while the proportion with Japan has fallen from 10 percent to 3.7 percent over the decade.

Most companies, regardless of the sector, identified increased international competition, primarily from south-east Asia, as having dramatic impacts on their companies. In particular, office and store machinery manufacturers and small appliance manufacturers have had to face this competition. In many cases, this has led to declines in market share and in the most dramatic cases has forced plant closures. The Japanese have been leaders in the rethinking of the manufacturing process. Advances in interactive management, industrial design and product quality have improved their competitiveness in addition to the advantages created by low wage and favorable exchange rates in the 1982-85 period. In small appliances manufacturing, the Japanese now dominate in the production of microwave ovens, and are leaders in the development of the latest 'smart' kettles and irons. Competition occurs even among new product technologies. For example, fibre optics is competing with satellite-based technologies for overseas communications.

3.1.3 Increasing Domestic and International Rationalization

Increasing competition and cost pressures have forced companies in some sectors to rationalize their operations both in Canada and, in case of the multinational corporations, on an international scale. International product and component sourcing as well as world product mandates are a result of the increased emphasis on world-wide efficiency. Companies have rationalized either by closing fringe plants and moving production to more central locations or by dedicating existing plants to single product lines. Each case has resulted in greater production efficiencies. Major appliance manufacturers traditionally work under small margins and, as a result of competition, the number of firms in the industry has diminished from more than 20 two decades ago to only three today. To stay competitive, these firms reorganized entire product lines to get maximum production runs. One plant may produce only washers and dryers, while another produces only refrigerators.

Another response has been for some firms to diversify into other more lucrative sectors. A small appliance manufacturer is now emphasizing electronics and defence products after recently closing its sole remaining North American plant. The consumer product portion of its business is now being sourced entirely from overseas. Other multinationals are turning Canadian manufacturing establishments into assembly plants, sourcing components from other companies or from overseas.

In some cases, this trend has helped Canadian manufacturers receive world product mandates from their parent companies. Examples of these mandates include both consumer products manufacturers and makers of highly complex electronics products. In other cases, Canadian companies have moved some of their manufacturing from Canada to other jurisdictions where the costs of production are considerably lower. One company indicated that high wage and government program costs are forcing them to have some products manufactured offshore.

3.1.4 Specific Issues Affected Some Industries

In addition to the trends which affected the entire industry, a number of trends had profound impact on some of the individual sectors. These trends include the decline of residential construction, off-oil and retrofit programs, shorter product life cycles, and changes in the legislative environment.

Decline of Electricity Generation Plant Construction

The decline in the building of electrical generating capacity due to moderating energy demand growth, slower economic growth, and energy conservation has had a pronounced impact on suppliers of electrical industrial equipment, particularly those companies with production lines dedicated to transformers, switches and cable. Electric power consumption has not attained the levels forecast a decade ago, leaving a great deal of excess generating capacity.

Slower Growth in Residential, Commercial and Industrial Construction

Slow growth in residential construction during the 1980s has forced the major appliance manufacturers to depend more on the replacement market. Housing starts are expected to range between 170,000-200,000 per year through 1990 according to government forecasters, down considerably from the 250,000 rate experienced in the mid-1970s. The growth of the trend to 'do-it-yourself' (DIY) installation affected a number of companies by restructuring the way in which products were designed, merchandised and delivered to consumers. In some instances, this resulted in the closing of sales offices or distribution arms of companies.

Growth in non-residential construction is expected to be better than in the residential sector, aiding producers of electrical industrial machinery, building control systems and heating products. The commercial sector is expected to be strongest over the next few years, as excess existing capacity in the industrial sector will limit gains in industrial construction.

Off-Oil Programs and Retrofit

Some companies such as those manufacturing electric heating units, environmental control devices and related products benefitted from government 'off-oil' programs and the emphasis on energy conservation during the late 1970s and early 1980s. However, declines in world oil prices after 1982 and only moderate increases recently have lessened the political push for such programs. As a result, there are fewer conversions to electrical heating products.

Shorter Product Life-Cycles and Increased Product Diversification

Many companies are reporting that product life-cycles and also manufacturing response times are becoming shorter. New process and equipment technologies have allowed producers to be able to meet market needs better, faster and with a wider variety of features and variations on each product line. Telephones, televisions, small and large appliances are examples of mature

products that have undergone dramatic feature changes over the past five years as a result of new technologies. For those in mature industry sectors, the hope is that increased product enhancement will encourage the replacement of older models and thereby regenerate what are otherwise mature markets.

For one company, expected pay-backs on new product developments must be within two years in order to proceed with the development of a new product. Even companies redesigning standard products (e.g., telephone sets) to incorporate new technology claimed that pay-backs had to be quick in order to prepare for further redesigns necessary to stay competitive.

Shorter pay-backs and rapid product changes are making the long range planning process more difficult, hence labour market and employment patterns are likely to continue to be unstable. Both employers and employees can not be sure that their product or process will remain in the same familiar form three years in the future and therefore must be prepared to be flexible.

Changes in the Legislative Environment

An example of this is deregulation in the telecommunications industry, which opened the marketplace to many non-traditional suppliers, mainly from overseas. Products such as the telephone set quickly became available from many suppliers, at many different price and quality levels and through various distribution channels. This affected the long-term viability of domestic manufacturers who have had to adapt to a more competitive business environment.

3.1.5 Recent Improvement in Markets and Sales

Most companies have been experiencing sales growth since 1984. Sales of products designed for electricity generation remain sluggish due to the oversupply of generating capacity. Other sectors which remain sluggish are companies within the scientific equipment sector who are supplying control

equipment to major process industries such as chemicals, petrochemicals and steel, which are themselves still suffering from the effects of low oil prices and reduced steel demand growth. The highest productivity gains occurred in the radio and television, communications equipment, and electrical industrial equipment sectors between 1982 and 1984. The slowest productivity gainers during this period were the appliances and lighting fixtures industries where the value of production did not increase enough per person-hour to cover general inflation.

Sales growth in other sectors has been caused by a number of factors including general improvement of the overall economy, development of new products and markets and, in some cases, Canadian companies receiving world product mandates as a result of restructuring by multinationals.

3.2 Industry Reaction to Trends

The industry has reacted to these trends in a variety of ways. To remain competitive, companies are increasingly emphasizing productivity, product quality, and development of their export markets and research and development capabilities. In response to shorter product life-cycles, companies have adapted their manufacturing processes to enable them to set up with shorter lead times and shorter production runs. Some companies have expanded service and maintenance to meet client needs or to develop new markets.

3.2.1 Emphasis on Productivity Throughout Companies

There will be a continuing emphasis on 'doing more with less'. Most companies see room for further production growth without increasing employment. While the value of shipments grew over 15 percent between 1982 and 1984, total employment increased less than 2 percent. Many companies were forced into improving their efficiency during the recession and learned that individual departments or divisions at all levels were able to function without as many personnel.

The expectation of higher sales growth relative to employment growth is universal in the industry, however, many of those interviewed believe that most of the paring of unnecessary workers had already been accomplished.

3.2.2 Emphasis on Product Quality and Deliverability

Many companies reported an increasing, if not an overriding, emphasis on product quality. This was motivated by a number of different considerations. First, it is perceived as necessary for competitive reasons. It is essential for Canadian producers to remain competitive with other suppliers. Many electrical products have to be highly durable and made to exacting tolerances if they are to be used as components in other equipment. To buyers, unit price becomes a secondary consideration if the efficiency of their process and product are valuable to the quality of the supplier's components. This is particularly true when just-in-time inventory methods are used, where reduced lead times and inventory sizes require components to be built and delivered right the first time. One company reported using its engineers to inspect and improve a component supplier's production methods to correct a defect in the part.

Second, quality is perceived as essential for efficiency and productivity reasons. Firms are discovering that quality built into the entire production process reduces waste, labour and materials costs. Inspecting a product only at its final stage of production catches defective products only after effort and costs have been incurred.

Third, in some sectors, emphasis on quality is fundamental since human lives may depend on the correct functioning of the product. Testing of the performance of these products is extremely rigorous and can involve specialized testing requirements, often on equipment designed especially for these purposes by these companies. Some companies require specialized occupations and training to carry out these procedures as, for example, in the aerospace industry.

Responsibility for product quality is now being spread throughout the manufacturing process. Production processes are increasingly being designed for the most efficient use of employee time and motion, materials handling, and organization of product components thereby improving product quality and serviceability. For example, the internal components of some washing machines are now being assembled on a base and the outer metal skin is placed around the assembly. Older machines have the internal components hung from the outer skin, making them more difficult to manufacture and service.

3.2.3 Development of Export Markets

Some companies were able to improve their sales in the past by developing export markets and now export considerably more than they have traditionally. Other firms, particularly those in the mature industries, are increasingly looking to export markets to generate sales. Many Canadian firms in the electrical and electronics industry depend almost solely on export sales for their revenues and are competing very successfully in world markets.

All sectors reported increased exports in 1984 and exchange rate developments since then have assisted Canadian exporters by making Canadian goods more competitive particularly in the United States. Productivity and quality improvements relative to foreign competitors could provide further export opportunities.

3.2.4 Trade Conditions

Exports

According to data compiled by the Department of Regional Industrial Expansion, the electrical and electronics industry contributed about 5 percent to total Canadian manufacturing exports in 1985. Current dollar exports grew from $1 billion in 1977 to over $5 billion in 1985. On a constant dollar basis, export growth has been consistent over this period except for a slight decline in 1982.

On a sectoral basis, the lighting fixtures industry experienced declines in exports each year from 1979 to 1982, but strong growth has been recorded since. Sectors that managed to avoid a decline in 1982 include radio and television receivers, communications, electrical industrial equipment, office and store machines, and scientific instruments. The recession hit the electrical industrial equipment sector with a lag, as indicated by an export decline in 1983.

1984 was a very strong year for export growth for the industry, with an approximate 40 percent jump in current dollar exports relative to 1983. This was due to a near 60 percent jump in exports for the communications sector, which accounts for roughly half of the total electrical and electronics industry exports. However, the communications, office equipment, and scientific instruments sectors experienced some weakness in 1985, slowing export growth for the industry as a whole.

As mentioned, the communication sector captured about 50 percent of total industry exports in 1985. This has grown from a low of 33 percent in 1978. The increase came mostly at the expense of the office equipment and the electrical industrial equipment sectors. The office equipment share dropped from 36 percent in 1976 to 29 percent in 1985, while the share accounted for by electrical industrial equipment fell from 11 percent in 1976 to 7 percent in 1985.

Imports

Imports of electrical and electronic products accounted for almost 12 percent of total manufacturing imports into Canada in 1985. The value of imports was about $11.5 billion in 1985. Import trends are similar to that of exports with a decline in 1982 and a strong increase in 1984, but there was a 2 percent decline in 1985.

Only the wire and cable sector had a significant increase in imports in 1982, with a gain of 62 percent over 1981. This was followed by a small decline of 3 percent in 1984 and a drop of almost 24 percent in 1985. Radio and

television and communications sector imports also experienced weakness in 1985, falling 6 percent and 1 percent respectively.

Imports of office and business accounted for the largest share of total imports in 1985, at almost 38 percent. The communications equipment share rose from 18 percent in 1976 to 25 percent in 1985. In 1985, radio and television imports accounted for 14 percent of the total, while electrical industrial equipment accounted for 8 percent.

Trade Balance

Canada imported about $6 billion more in electrical and electronic products than it exported in 1985. Almost all sectors experienced a trade deficit over the 1976 to 1985 period. The lone exception is the wire and cable sector which exhibited trade surpluses in 1978 through 1981 and again in 1985. Specific requirements for Italian and Norwegian submarine cable in 1982 and 1983 appear to be the main cause of a balance deficit in those years.

3.2.5 Increased Emphasis on Research and Development

Most companies in all sectors reported an increased emphasis on research and development and saw this as key to their continued survival. This emphasis coincided with the need to find new products and markets as a result of shortened life cycles of existing products and the need to stay ahead technologically in order to remain in business. Multinationals have traditionally left research and development as the responsibility of the parent company. However, as many industrial markets mature, subsidiaries are being given more scope for research and development, particularly if they have developed special expertise that can be used in other markets. Technological advancements have also allowed specialized product designs to be made faster and at less cost.

Although several companies are spending up to 10 percent of sales on research and development activity, this is not common throughout the industry. Some companies have adopted a decentralized approach to research and development where employees are given time and money to help improve existing

products or to work out the development of new products. The use of these funds is monitored to ensure that employees continue to experiment with new and innovative ideas.

Another company sees its role as being the designer and developer of new products which it perceives will eventually be manufactured in countries with lower costs of production once the market matures.

3.2.6 Shorter Lead Times

Competitive pressures are reducing lead times for product design and manufacture, reflecting the fact that many of their customers are also operating in a more competitive environment. Reduced turnaround time has been facilitated by both the adoption of increasingly complex design and production technology and by altering production methods to reduce idle time. In several instances, this trend has increased the number of high-skilled engineers relative to the number of lesser-skilled workers because more effort is being devoted to the design stages of the production process.

3.2.7 Shorter Production Runs

Technology is reducing the need for scale economies attained through traditional means such as increasing the size of the production line and lengthening production runs. As the cost and speed of new production technologies continue to lower unit production costs, products and markets which were previously uneconomic become increasingly more feasible. Computer-aided design (CAD), computer-aided manufacturing (CAM), computer-integrated manufacturing, electronic links to suppliers and customers and just-in-time inventory methods are reducing the 'minimum efficient scale' of production. (These technologies are discussed in more detail in Section 4.) Smaller custom orders are now being produced as efficiently as large orders from traditional mass production assembly lines. Shorter production runs will require firms to be more adaptable and flexible in structure and employment.

3.2.8 Growth of Maintenance

Some new markets are being created in the maintenance of electrical and electronic products. This applies to both the servicing of electrical products and the servicing of manufacturing equipment. In both cases, the skills necessary for servicing and maintenance of today's equipment are becoming less dependent on craftsmanship and more dependent on diagnostic skills. This is particularly the case with automated production lines. Once a problem is isolated, its solution may mean replacement of a component or circuit board, rather than repair of a part.

Competitive pressures have also increased company awareness of after-sales service and maintenance as a profitable market opportunity. While initially companies have expanded or established service arms to maintain their own equipment and products, some companies are now attempting to provide servicing of competitors' products, or products in related technologies.

Servicing and maintenance activity has a much more stable business cycle than the manufacturing sector. Economic downturns force customers to delay purchases of new equipment, and increase servicing of existing equipment. This fact, and the impact of the 1982 recession, have induced some companies to expand their servicing capabilities.

3.2.9 Service Activities

As mentioned in Section 2.11, four types of 'service' companies were examined including telephony, environmental control systems, repairs of home entertainment equipment and security systems. In summary, activity in this sector is separated into two areas, namely, retrofit and repair, and new installations. The performance of most of these companies is affected by a number of considerations including government policies and regulations, residential, commercial and industrial construction activity, oil prices, general economic activity and disposable income. The retrofit and repair activities appear to be more stable as customers delay investment in new installations when

the economy is not growing. It appears that growth will continue to be stronger in the retrofit of existing facilities in the near future. At the same time, work on new installations broadens the customer base and eventually leads to subsequent need for repair and retrofit.

Many of these firms also reported practice of third-party maintenance, that is, they will repair equipment made by other manufacturers or installed by their competitors. Competition is very strong, ranging from companies in the same area of expertise, to specialty firms, OEMs (original equipment manufacturers) and small entrepreneurial companies.

Few of these services can be easily exported, as most countries already have a well-developed service sector. However, Canadian expertise and knowledge can be exported. There are instances, such as some control and security systems companies, where personnel in Canadian-based firms are valued for their level of expertise. In such cases, Canadian experts are loaned, or their expertise is sold, to other countries for design and installation of new systems. A local branch or company usually then assumes the maintenance contract.

3.3 The Employment Outlook

The industry reports that the employment outlook is likely to be for slow growth at best and that the volatility in the labour market experienced in the past is likely to continue. Appendix III contains the survey estimates of total employment with an occupational breakdown for the 1981 to 1988 period.

3.3.1 Slow Growth in Employment

Companies expect that the drive toward productivity will continue and that because of continued technological developments, increases in output will not be matched by equivalent increases in employment. Even companies in telecommunications and aerospace who expect to see a dramatic increase in sales

over the next five years stated that this would have to be achieved with only a minimal increase in the number of employees, particularly at the production level.

Since the electrical and electronics manufacturing sector has been creating many of the products which other industries have been adopting to improve their own productivity, some sectors such as electrical industrial equipment, and scientific instruments will experience both the positive and negative implications of productivity and technological changes.

The aggregate change in employment in this sector from 1983 to 1986 is 4.5 percent, a respectable rate by historical standards, and significantly higher than that for the manufacturing sector as a whole (see Table 3.2). However the change was not broadly based. Growth was due disproportionately to the

Table 3.2

Electrical and Electronics Manufacturing Industry
Employment by Sector

	1983	1984	1985	1986	Percent change 1983-86
Small electrical appliances	4,102	3,622	3,482	3,591	-12.5
Major appliances	7,855	7,669	7,878	7,773	-1.0
Lighting fixtures, lamps, shades	3,752	3,531	4,149	4,863	29.6
Radio and television	3,662	3,800	3,881	4,245	15.9
Communication equipment	42,905	45,105	46,961	47,563	10.9
Electrical industrial equipment	20,338	21,236	20,894	21,709	6.7
Electric wire and cable	9,103	9,321	9,500	9,427	3.6
Office, store & business machines	13,126	13,642	15,421	16,364	24.7
Miscellaneous electrical products	12,193	12,750	13,191	14,100	15.6
Scientific equipment	31,217	30,280	28,149	25,282	-19.0
Total electrical and electronics	148,253	150,956	153,506	154,917	4.5
Annual percent change		1.8	1.7	0.9	
Total manufacturing sector	1,739,000	1,670,000	1,704,000	1,741,000	0.1
Annual percent change		-4.0	2.0	2.2	

Source: Statistics Canada, Cat. 72-002 'Employment, Earnings and Hours' (monthly averages*)

*1983: Mar-Dec
1986: Jan-Nov

communications equipment, office and store machinery and lighting fixture manufacturers, and due generally to the rebounding markets in Canada and the U.S. after the recession. The small and major appliance sectors together with the scientific equipment industry have been the weakest in terms of job creation. As the economy expands at a slower rate in the mature phase of the business cycle, future employment growth is not expected to be strong. Although companies tend to be optimistic about their own prospects, most did not see a particularly bullish period ahead for their markets and each expected employment growth to be fairly slow at best.

3.3.2 Volatility in the Labour Market is Likely to Continue

General market considerations, developments, acquisitions and divestitures have had a much greater impact than technological developments in terms of reducing employment levels in the industry. Such developments have forced companies to address fundamental issues such as whether in view of market developments it should continue to manufacture certain products, whether it should relocate its production facilities in other jurisdictions, and whether as the result of an acquisition it should close down operations which it may perceive as duplicating operations in other production facilities. These developments will continue to create volatility in the labour markets and perpetuate the problematic cycles of layoffs and recalls.

Companies expect these trends to continue on a global scale. Firms in some sectors, such as aerospace, anticipate that a few large companies will eventually control significant segments of the market, as has occurred in the major appliances sector. An increasing number of joint ventures between these companies on a global scale is also anticipated.

3.3.3 The Contribution to Employment by Small Business and by New Enterprises

Small businesses in the electrical and electronics industry, as in the rest of the manufacturing sector, were the only source of net employment growth in the

1976-84 period. The importance of small companies is dramatically illustrated in Table 3.3 below.

Table 3.3

Employment Growth in the
Electrical and Electronics Manufacturing Industry
by Establishment Size (1976-84)

No. of Employees	Electrical and Electronics Sector	Total Manufacturing Sector
0-19	95.1%	42.1%
20-49	26.7%	4.1%
50-99	-6.0%	-11.2%
100-199	-18.9%	-23.3%
200-499	-22.9%	-22.2%
500+	-4.0%	-1.0%
Total	6.0%	-3.3%

Source: Department of Regional Industrial Expansion

The electrical and electronics industry fared better than the manufacturing sector as a whole. During the 1976-84 period, employment in the electrical and electronics industry grew 95 percent in businesses with less than 20 employees and 27 percent in the 20-49 employee group. In the manufacturing sector as a whole, employment gains were 42 percent and 4 percent respectively. The major source of employment declines were the medium-sized firms, that is, those with between 100 and 499 employees.

There was a net increase in employment in this industry because jobs created by new businesses more than offset the losses created by shutdowns. However, of the firms that survived, jobs lost by company contractions outnumbered jobs gained by expansions. In contrast to the electrical and electronics industry, the total manufacturing industry had a net decline in employment during the 1976-84 period. New firms and expansions did not generate enough employment to offset bankruptcies and contractions (see Table 3.4).

Table 3.4

Net Change in Employment in the
Electrical and Electronics Manufacturing Industry
by Component of Change (1976-84)

	Electrical and Electronics Sector	Total Manufacturing Sector
Net Change	0.6%	-3.3%
Start-Ups	42.3%	27.3%
Closings	-39.0%	-32.2%
Expansions	12.9%	14.6%
Contractions	-15.6%	-12.9%

Source: Department of Regional Industrial Expansion

3.4 Summary Findings

1) The Industry has been Experiencing a Period of Upheaval

A number of developments have contributed to a particularly difficult period for the industry in the recent past. Many companies have been facing increasing competition from offshore manufacturers. Competition and cost pressures have forced some companies to rationalize both nationally and internationally creating painful adjustments in the sector. Layoffs of the work force have been commonplace. As a result of its close relationship with other parts of the economy, markets dropped off considerably for many of the industry sectors during the 1981-82 global recession. The decline in construction hit many hard, as did recession in resource industries which affected many manufacturers in western Canada. Shorter product life-cycles caused by shifting consumer tastes and product innovation and diversification created considerable volatility in some markets.

Total employment levels declined almost 14 percent between 1981 and 1983, and have yet to regain pre-recession highs. The reason for the slow rebound in employment is in part due to slow growth in markets. It is also due to an overriding emphasis on productivity - doing more with less is the name of the

game. Business practices adopted to increase productivity such as rationalization, product advances, new production methods and new management techniques are creating a more competitive environment which in turn is increasing the need for firms to operate with the best possible efficiency and flexibility.

2) The Industry has Reacted in Many Ways

The industry has reacted in a variety of ways. For some sectors, such as consumer electronics and communications, change has been dramatic - for other more mature sectors, such as electrical industrial equipment and lighting fixture manufacturers, change has been more incremental. The drive toward improved productivity is universal and perceived as essential for survival. Companies everywhere are also striving for improved product quality. Spurred by improved quality of products from overseas, an emphasis on product quality is necessary to remain competitive. Companies cannot afford to produce without high-quality components, and assembly performed to consistently high standards throughout the production process. Components and parts delivered to manufacturers must consistently be of high quality since many are adopting just-in-time inventory management systems and a defective part could cause expensive interruptions in production. Further, quality can sometimes be critical since human lives can depend upon the proper functioning of certain products manufactured by the industry.

Shorter product life-cycles now require that pay-backs on many new products be within a short period. Increased product diversification and shorter product life-cycles mean producers must react quickly to changes in market conditions. The lead times in setting up production and the runs themselves are shorter than several years ago. Research and development to find the niches and develop new products are receiving a new emphasis even in mature sectors of the industry.

To develop new markets, many in the industry are increasingly exporting. Some large companies have received international product mandates from their parent organizations which have formalized their export strategies.

Some companies have established separate service and maintenance operations which they see as a growing market opportunity both for the servicing of their own and their competitors' products.

3) The Future Looks More Encouraging, but Planning is Difficult

The competitiveness of the market, with many new and changing products and processes is creating a volatile operating environment for many producers of electrical and electronics equipment. This fast and rapidly changing environment is becoming a permanent characteristic of the industry. Planning is thus made more difficult and many of the firms interviewed have difficulty projecting their own business plans and employment requirements more than two years in the future. Some sectors expect to see strong growth in sales over the next five years - others are trying to maintain their current position. Most expect sales increases.

4) Growth in Employment will be Slow and Volatile

Many companies believe that the elimination of surplus employees has been accomplished to a large degree. Large increases in employment are not expected as sales rise in the future. Greater uncertainty in the long-term market prospects for many products is now commonplace. Volatility in the labour market unfortunately will be the norm. Job security at all levels will be an increasingly fragile concept. Employees in all sectors of the industry, including those on the leading edge, are uncertain of their prospects even two or three years down the road. For some industries, layoffs and recalls have become a common strategy in meeting the vagaries of market demand for their products.

The mutually reinforcing drive toward improvements in productivity and product quality are forcing manufacturers to adopt the new technologies throughout the organization. The result is better quality with fewer workers. Even where sales and market growth are buoyant, the productivity imperative means that employment is likely to grow slowly at best.

4. THE NEW TECHNOLOGIES

The discussion in this chapter deals with the industry's response to the adoption of new technologies and its effects on the production skills of the work force. Companies are adopting new manufacturing technologies because of the mutually reinforcing needs to improve speed, product quality and productivity. These technologies can be classified into two groups. The first is 'hard' technologies, a term used to refer to technologies which directly influence the design and production processes, such as CAD, CAM, and robotics. The second group is 'soft' technologies, referring to those which indirectly affect the production process, such as statistical process control, quick set-up, and new approaches to work organization.

For each technology discussed in this chapter, there is an accompanying graph (Figures 4.1 through 4.9) which summarizes the questionnaire survey results in terms of the 'cumulative adoption rate' of technology. This refers to the total share of respondents who have adopted a specific technology, cumulated year by year. Many of the curves illustrated are S-shaped, a common finding for the introduction of new products. The theory behind the S-shaped curve is that initially there is a slow period of adoption when only a small portion of the industry introduces the new technology soon after it is available. Once the technology is proven, the industry mainstream then quickly adopts it. The adoption rate then tails off once again as the technology matures and most companies that can benefit from its use have introduced it. Depending on the product or process, this S-curve may spread across one year or many years.

In this study, one interpretation of the S-curve may follow this theory. The survey results do indicate a flattening-out of the cumulative adoption rates before the year 1990 in most cases. This may be sooner than what should be expected as it is possible, and even probable, that the flattening-out generally has more to do with a company's uncertainty about its future plans concerning its production or management process, rather than a real expectation that adoption rates will decline. This caution should be noted when referring to the adoption rate figures.

The data presented in this section refer to the survey results and may or may not represent conditions in the industry as a whole. Although well distributed among the major industrial categories, the survey sample is biased toward large and medium-sized firms. These firms are generally more likely to adopt new technologies earlier and at a faster rate then smaller companies. The questionnaire asked for the initial year of adoption, the number of units in use at the time of the survey, and the qualitative expections concerning future changes from the current level of use through to 1990. As a result, the data does not include any additions to, or replacement or upgrading of, a process or piece of equipment after the date of initial adoption. This then may underestimate the true level of penetration of a particular technology throughout the industry. Also, trends in further developments of that same technology within a company are not captured.

For the discussion below, the respondents were categorized by size according to the number of employees. 'Small' firms have less then 100 employees, 'medium' firms have between 100 and 499 employees, and 'large' firms have 500 or more employees.

4.1 Impacts of 'Hard' Technologies on Production Skills

The 'hard' technologies are those which have a direct relationship to the production process. There is a trend towards more semi-automated and totally automated production processes which replace labour-intensive and particularly dirty and uncomfortable work on the production line. Companies are automated to varying degrees even within the same sectors. Generally there is an evolution of technology on the production line which may, for example, involve supplementing manual labour with mechanized aids and gradually adding more sophisticated equipment. This includes numerically controlled (NC) machines, computer-controlled NC machines, programmable controllers, electronic testing of equipment, CAD, CAM, semi-automatic soldering machines, and robots. These technologies are addressed in this section.

4.1.1 Programmable Automation

Numerically controlled (NC) machines are devices which cut metal according to programmed instructions via paper or plastic tape. The computer-controlled NC machine (CNC) is similar to the NC machine except that instructions are stored in a dedicated microprocessor and delivered to the machine electronically. Programmable controllers are small, dedicated computers used to control or monitor a variety of production processes. Generally, companies are making increased use of these technologies and may have had these for some time.

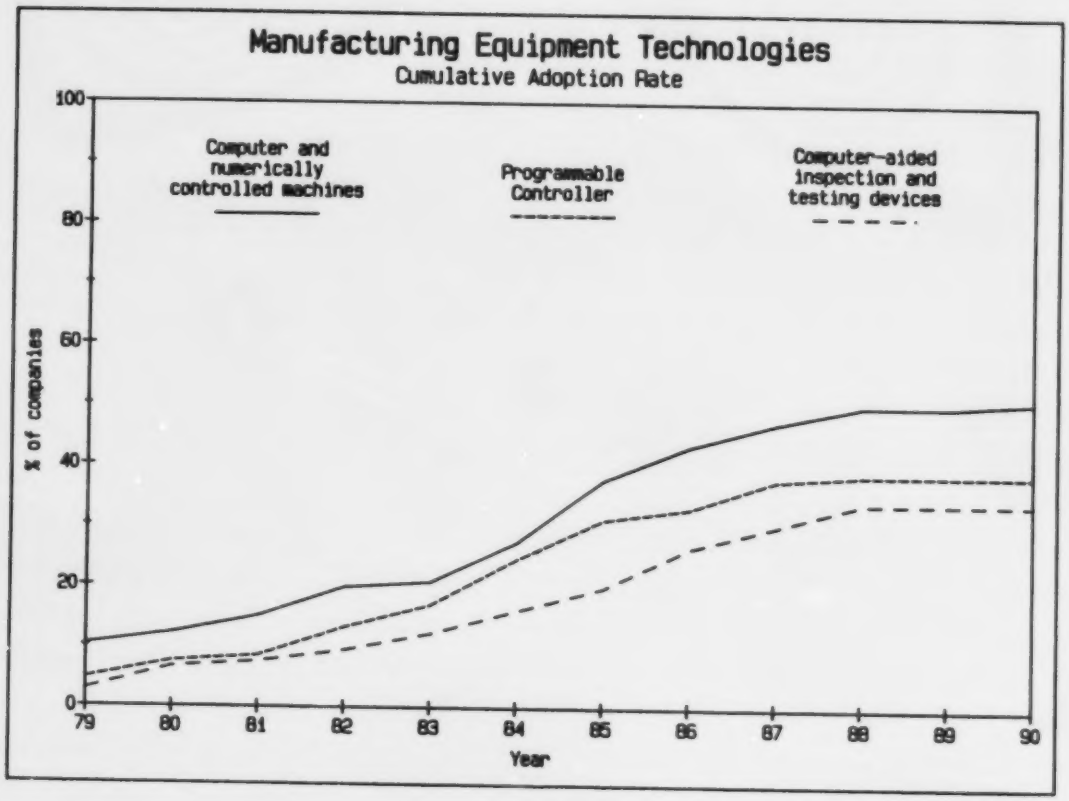
For many in the industry, inspection requirements have become progressively more stringent and sophisticated. This has increased the need for computer-aided inspection devices. These devices may include robots and programmable controllers, which are used to measure or test production output automatically.

Adoption Rate

One company remarked that NC machines are already obsolete, but 5 percent of the respondents reported adoption plans for the years after 1986. This is in addition to the 21 percent of respondents who had installed 76 machines by 1986. All sizes of companies are using NC machines but the concentration is in the 'small' and 'medium' categories. This is one of only three technologies that some companies (3 percent of respondents) plan to phase out by 1990. The majority, however, expect to increase the use of NC over the rest of the decade. Only companies in the small and major appliance industries did not report the use of NC technology to date and have no plans to adopt it by 1990.

CNC machines had been adopted by 21 percent of the respondents by 1986, distributed among the office and store equipment, lighting fixtures, communications, electrical industrial equipment, miscellaneous products and scientific instruments manufacturers. Use is also distributed evenly between small, medium and large firms. On average, each respondent reported having two

Figure 4.1



machines at present. However, only 11 percent of the current users have plans to increase the use of CNC machines in the future. An additional 6 percent of respondents, across the lighting fixtures, electrical industrial equipment and scientific instruments sectors, plan to adopt CNC machines after 1986. There are no 'large' companies in this group. Companies in the small and major appliance, radio and television, and wire and cable industry groups did not indicate any plans to adopt CNC machines by 1990. The adoption trend for NC and CNC machines have been aggregated in Figure 4.1.

Programmable control technology is one of the more widely adopted in terms of the number of units, averaging 7.4 units per company in 1986. The 37 percent of respondents that use the technology are distributed across all sectors

and all employment size groupings. The adoption rate appears to be near its peak, with only an additional 6 percent of mainly 'small' and 'medium' respondents planning to introduce it by 1990.

Approximately 28 percent of those surveyed use an average of four computer-aided inspection (CAI) machines each. By 1990, it is anticipated that 35 percent of the respondents will be using CAI. Only those in the lighting fixtures and wire and cable sectors did not report use of this technology before 1986 and only lighting fixture manufacturers do not expect to adopt CAI by 1990. There is no significant distinction between employment size groups.

Impacts on Skills and Occupational Requirements

Usually the automation of the production process and the adoption of a new technology occurs gradually over a period of time rather than all at once. The training issue for an employee therefore becomes one of upgrading on a new piece of equipment rather than having to learn an entirely new skill. Within a company, job displacement due to technological change also tends to be gradual rather than dramatic. Some companies felt that the jobs lost through automation would largely be offset by jobs created by market and business growth. Many of the technologies identified in this section require the operator to have either basic literacy or numeric skills since the technologies require that machines be programmed from a set of specifications. The operator is becoming less involved in the hands-on production skills and more involved with monitoring and controlling the production process. We will address these issues in more detail in Chapter 5.

Some companies reported that they perceive the most unskilled jobs to be at the greatest risk of displacement from automation. For example, those involved with manual movement, such as lifting or handling of goods on the production line, are easily replaced by machines. The potential for employment loss is therefore much greater in companies with a large share of unskilled labour.

Occasionally companies develop technologies which are unique to their particular sector. One firm in the consumer products industry is cutting two-thirds of its unskilled work force in some areas because of a new and unique manufacturing process.

4.1.2 Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE)

CAD is a technique involving the application of the computer to the design process. It may use interactive workstations for the preparation of designs. Typically the technology allows the designer to have three-dimensional views of the product. The technology also provides a mechanism for easy storage of designs and simplified alterations to specifications which can improve productivity and efficiency in the design and engineering stages of components and products.

Computer-aided engineering (CAE) is an enhancement of CAD through which the engineer can 'test' designs of both products and circuits before they are manufactured.

Adoption Rate

The survey results indicate that CAD is the most widely adopted of all of the 'design' technologies illustrated in Figure 4.2. There is growth throughout the period with a relatively steep rate of introduction between 1983 and 1987. The 37 percent of respondents that had adopted CAD by 1986 operated an average of 2.3 units each, and the majority planned to increase its use in the future. At present no respondents in the lighting fixtures, radio and television, and wire and cable industries use CAD, but it is expected that all sectors will have this technology by 1990, and notably most of them will be 'small' and 'medium-size' firms. By then the cumulative adoption rate is expected to be 60 percent.

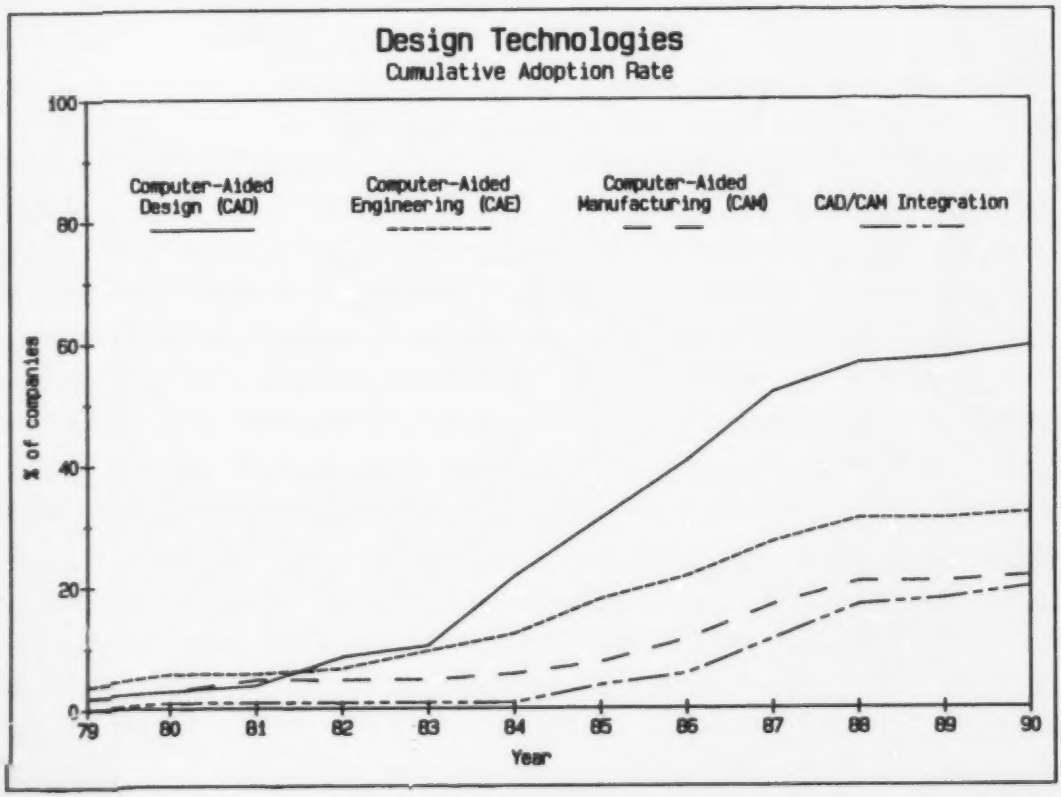
Prior to 1982, the survey shows that more companies were using CAE than were using CAD. The situation reverses in 1982 and by 1986, 22 percent of respondents reported using CAE. Companies in the major appliances, lighting

fixtures and radio and television sectors are not currently using this technology. By 1990, all sectors expect to use CAE and the cumulative adoption rate is expected to rise to 34 percent. However, use will be concentrated in the larger firms.

Impacts on Skills and Occupational Requirements

The main impact of CAD and CAE is on the skill levels required of design engineers and draftsmen. Rather than sitting at a drafting board and producing measurements and designs done by hand, draftsmen must be comfortable with the use of a computer terminal, screen and the applicable software package. Design engineers also need to be computer literate, using a CAE system to formulate a test of a design and then understand how to interpret the results to make necessary adjustments to the specifications.

Figure 4.2



These technologies help make the design and testing process faster and cheaper. Therefore, firms are more willing to expand their design departments and spend more effort in the design stage of a product. Most companies have been able to introduce these technologies by means of upgrading existing engineering and design staff.

4.1.3 Computer-Aided Manufacturing (CAM) and Integrated CAD/CAM

The logical next step to computer-assisted design is computer-aided manufacturing (CAM). This technology involves the use of computers to assist in the production process. The integration of CAD and CAM allows for the transfer by computer of product specifications developed during the design stage, to the machines engaged in the actual production. The process also allows for the storage of design and production specifications on the computer memory disks which in turn causes a reduction in set-up time for future production runs. The advantage of CAM and integrated CAD/CAM is that they improve productivity, reliability, and reduce set-up time and human error.

Adoption Rate

The adoption rate for CAM is only 11 percent by 1986. Despite this relatively low rate, the average number of units per respondent is in excess of 5. This is more than double the average for either CAD or CAE. Most companies anticipate increasing the use of CAM over the next four years, and together with new adoptions, the penetration rate is expected to be 21 percent by 1988. However, the industry did not indicate any new installations after that. There is no adoption of CAM forecast by those in the major appliance and lighting fixtures sectors.

The cumulative rate of adoption of the integrated CAD/CAM technology remains one of the lowest found in the survey. The rate has risen to only 5 percent by 1986. The firms that do currently use it, however, do so

intensively. They are also relatively large and represent only the office and store machinery, communications and electrical industrial equipment sectors. By 1990, the cumulative adoption rate is anticipated to rise to almost 20 percent, but many sectors (small and major appliances, radio and television, and wire and cable) do not expect to adopt this technology by that time.

Impacts on Skills and Occupational Requirements

In companies which are implementing CAD/CAM technologies, retraining of the existing work force is a first priority before seeking outside skills. In some cases the training for these technologies is provided by equipment vendors and in some cases is supplemented by training themselves on their own initiative.

In a few cases, the introduction of CAM has reduced the number of employees gradually, but these individuals are usually given the first opportunity to apply for other jobs in the company.

4.1.4 Robotics

Robots are reprogrammable, multifunctional manipulators designed to move workpieces or tools along various paths. Most companies interviewed are developing an increasing awareness of robotics and a few are beginning to experiment with their use. Some companies felt that the technology was not used and appreciated for its flexibility to the extent possible. They commented that operators tended not to experiment with the technology, believing that the design staff should be responsible.

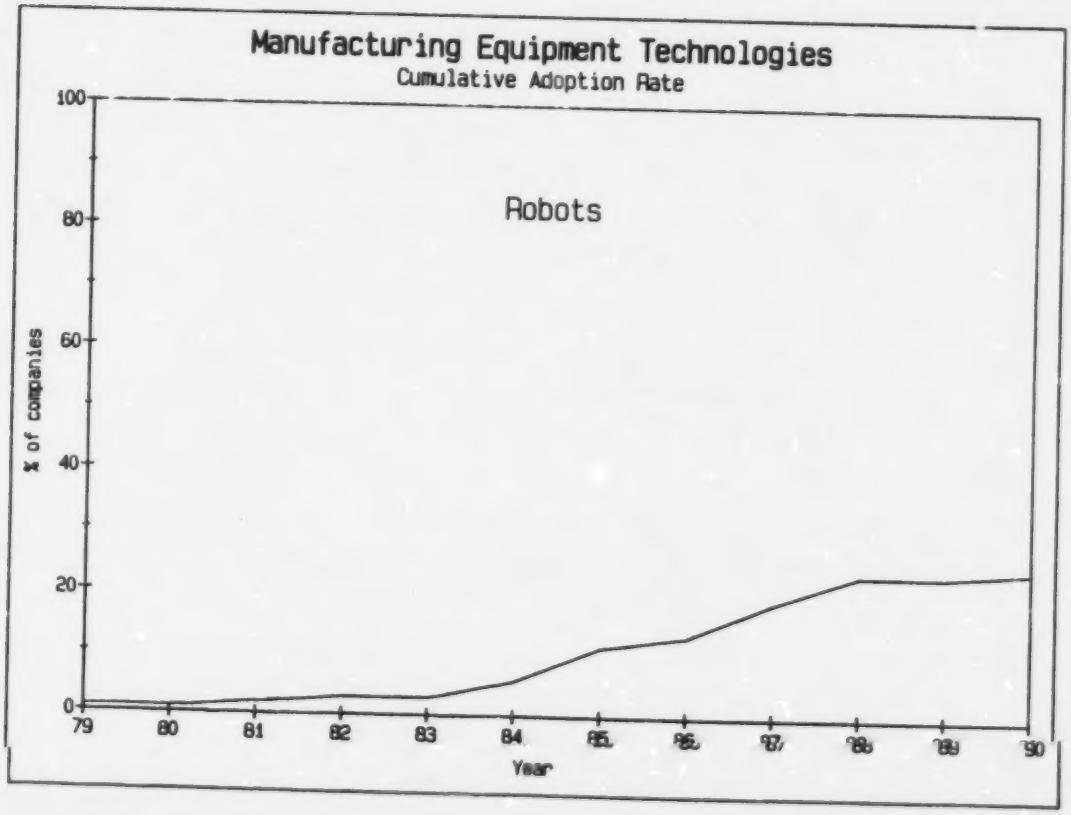
Adoption Rate

Only 14 percent of firms have adopted robots by 1986 (see Figure 4.3), none of which have less than 100 employees. All the sectors have at least one robot now, with the exception of the lighting fixtures industry, and the wire

and cable industry. The cumulative adoption rate grows to 27 percent by 1990, with the firms concentrated in the small appliance, radio and television, communications, electrical industrial equipment, and wire and cable sectors. Only two of these additional firms are 'small'. According to the survey results, only the lighting fixtures sector will not be using robots by the end of this decade.

From the interviews, robots were generally seen to be on the horizon (anywhere from 5 to 20 years) for some assembly-oriented manufacturing operations. However, according to companies surveyed, robotics are not likely to be used on a wide scale in the industry. Some companies indicated that due to the limitations of the technology they did not see robotics as being an appropriate technology or sufficiently 'refined' to be adopted successfully in their own manufacturing environment.

Figure 4.3



Impacts on Skills and Occupational Requirements

Some companies which have implemented robotics are educating their employees to reduce anxiety and increase understanding of robotics before they are purchased and implemented. Some companies interviewed expressed dissatisfaction with the use of robots. However, the largest firm in the industry has successfully adopted robotics and has had to lay off workers as a result. Since robots can and may potentially do some of the work now being done by large numbers of assemblers, it is conceivable in the longer term that large numbers of jobs will be displaced by this technology.

4.1.5 Service Technologies

There have been dramatic changes in many of the products and processes associated with the electrical and electronic service industries over the last five years. However, it appears that a peak in the rate of change has been reached. One product change has been in controls - from pneumatic, to electro-mechanical, to electronic. Since pneumatic equipment is still relatively inexpensive, technologies are being combined. For example, pneumatic controls may be attached to electronic sensors. Some companies are introducing remote servicing and centralized dispatch. Also, quality control is increasing in importance, much as it is in manufacturing.

Impacts on Skills and Occupational Requirements

Service companies, even with the increasing adoption of sophisticated diagnostic equipment, are having to learn how to service a wide array of systems and equipment. Increasing service skills are necessary to maintain or expand their client base. Board swapping is another result of evolving technology, whereby instead of repairing a circuit board on-site, the technician simply replaces the entire board. The defective one is either discarded or sent to a central point for repair. Although the skills required to replace the board are

not particularly difficult, it may in fact require considerable time to isolate where the problem is occurring. One employee we spoke with said that 'under the old technologies it took 5 minutes to find a problem and a day to fix it - with the new technologies it takes a day to find the problem and 5 minutes to fix it.'

Technicians make up the largest occupational group in the service industry. The entry-level technicians generally have a diploma from community colleges or technical schools with a basic background in electronics or computer programming. The companies hire graduates with technical degrees in various disciplines, and then train them for their specialized equipment. The majority of firms interviewed, however, believe the electronics courses offered today are becoming increasingly out-dated and are in need of standardization. The majority of technicians are male. Almost all project managers are technicians who have worked their way up. Those who reach higher levels of company management and administration tend to be the university-trained engineers. There was little need reported for engineers or individuals with a university background in the service companies, except for the environmental control systems firms.

The ratio of technicians to clients is decreasing as equipment and process changes improve productivity. This has implications for the skill mix over time. For example, technicians will be expected to do more programming in addition to the installation of a system. Retrofit and repair is expected to evolve towards trouble-shooting and away from on-site repair. Technicians will therefore increasingly be required to have more diagnostic and analytical skills rather than mechanical skills. This role may alter again in the future as equipment becomes more self-diagnostic and remote servicing becomes possible.

Sales representatives account for another significant portion of employment, and their numbers are expected to remain relatively stable. Qualified and technically literate sales people are reportedly difficult to find. Subcontracting of tradespeople such as electricians occurs on a small scale. Demand generally depends on the number, size and type of projects underway.

4.2 Impacts of 'Soft' Technologies on Production Skills

'Soft' technologies are defined as those which have an indirect influence on the productivity and efficiency of the production process. They include: new forms of work organization such as self-managing work groups, quality circles and quality-of-working-life programs, quick set-up techniques and statistical process control. These technologies encourage the increase of an individual's level of responsibility at the workstation for quality control and production management. They are presented in Figures 4.4 and 4.5.

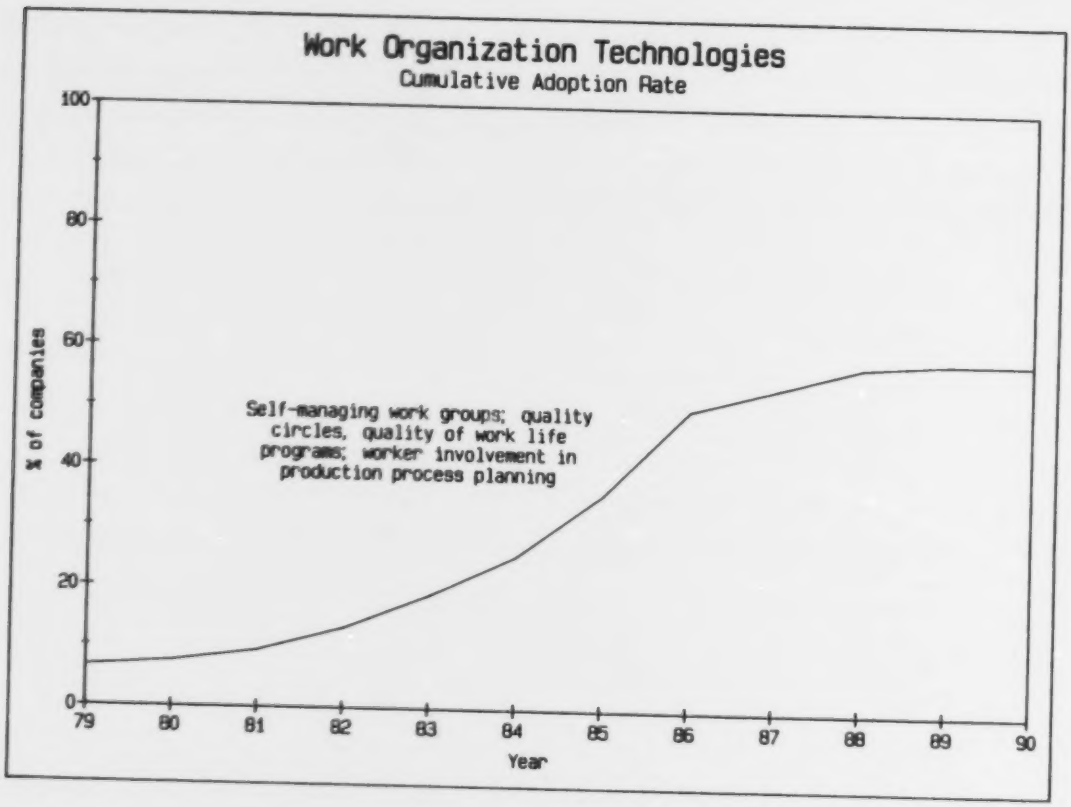
4.2.1 Self-Managing Work Groups

A number of companies have transferred more responsibility for quality control and production efficiency to the individual line worker. This trend has been variously described as self-managed work groups, quality-of-working-life programs (QWL), quality circles (QC), and other names which reflect increased worker involvement in production process planning and monitoring. Employee group structures that provide motivation and self-policing can improve product quality, production speed and efficiency. About 40 percent of the industry now has some form of work organization along these lines.

A few companies have introduced formal quality circle programs. Quality circles are small groups of workers with control over aspects of the production process that were once the responsibility of a manager or supervisor. Modelled after Japanese forms of work organization, these small semi-autonomous groups may be directly responsible for the quality of their production and may be encouraged to suggest improvements to the manufacturing process. These groups may also rotate job tasks to some extent amongst themselves.

Companies differ in their attitudes to the benefits derived from more de-centralized forms of work organization. Some companies may have had these forms of work organization in a less formal manner for many years. Other companies feel that there are a number of productivity and labour relations issues which require resolution within their own companies before they begin to experiment with these methods.

Figure 4.4



Adoption Rate

Collectively, self-managing work groups, QCs and employee involvement programs had been adopted by 41 percent of respondents by 1986 as illustrated in Figure 4.4, and an adoption rate of 60 percent is expected by 1990. On an individual basis, QWL is the most common program. It had been introduced in every sector except small appliances. A small number of companies (6 percent) are using self-managing work groups at present, although the adoption rate is expected to double by 1990.

On a sectoral basis, there were no plans in either the radio and television and wire and cable sectors to start self-managing work groups, while radio and television manufacturing also had no plans to use worker involvement programs by 1990.

Three-quarters of the companies who have already adopted at least one of these programs are in the small and medium size categories, indicating that it may be more difficult to introduce them in the larger and more traditional organizations.

Impacts on Skills and Occupational Requirements

As a result of more decentralized forms of work organization, workers are expected to be responsible for monitoring the quality of production and may be expected to diagnose problems when these occur. They may also be required to be flexible as production changes from one product to another. This has required that workers increasingly be able to work together to analyze problems and recommend solutions or ways to enhance productivity. One implication of the implementation of quality circles is that they may eliminate the need for some supervisors and inspectors.

4.2.2 Quick Set-Up

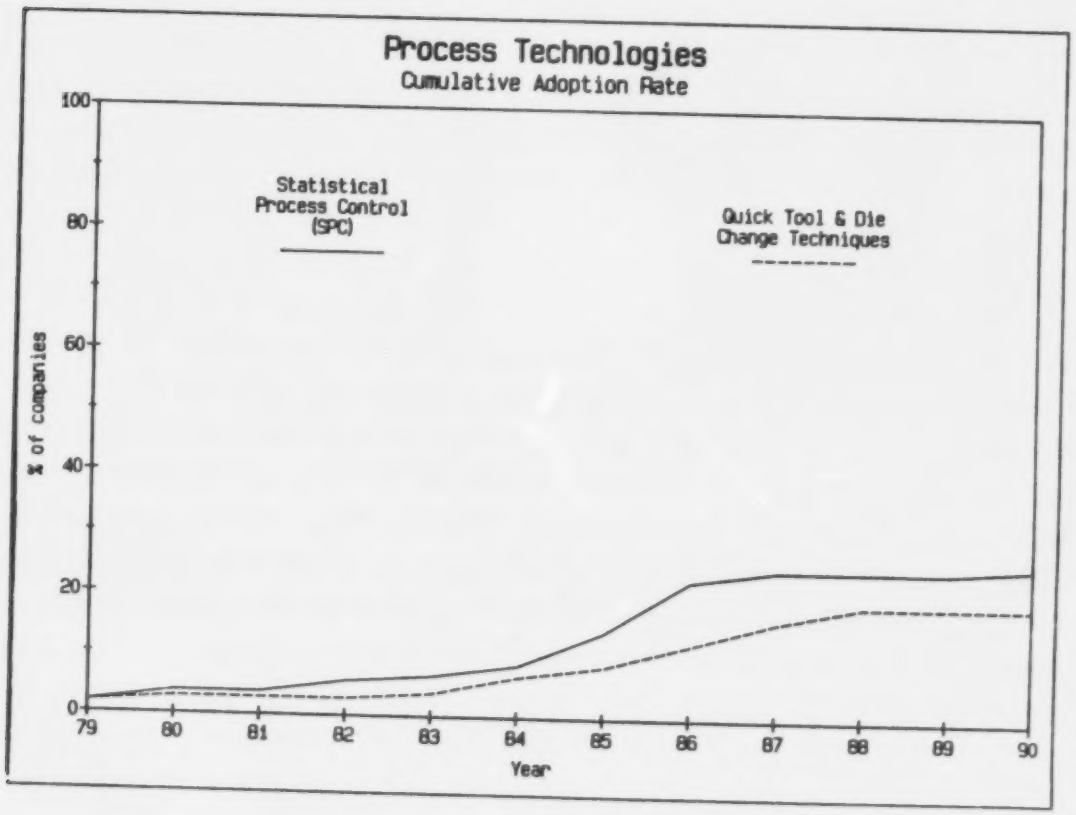
The trend toward shorter production runs is made possible by 'quick set-up' which is a term used to include a number of operations, such as quick tool and die change, which allow employees to retool or change production runs with a minimum of down time. In some environments the set-up time is measured from the time production is shut down until the time production recommences on the new product being manufactured. In other companies, set-up time is measured until the time that production is occurring within specified quality guidelines and includes time spent adjusting the production process to eliminate errors and achieve acceptable levels of product quality. Regardless of which method is used, companies are placing an emphasis on rapid set-ups requiring a minimum of rework.

Adoption Rate

In the questionnaire survey, respondents were asked about their use of quick tool and die change. The use of this technique is not widespread across

companies. This is evident in Figure 4.5. Only 10 percent of respondents indicated its use. It is likely that a number of companies use other techniques but do not refer to them as 'quick tool and die change'. Total adoption of quick tool and die change techniques is not expected to exceed 20 percent of the industry by 1990, but all sizes of firms and all sectors will be represented except major appliance and radio and television manufacturers.

Figure 4.5



Impacts on Skills and Occupational Requirements

The trend toward quick set-up has had a number of impacts on job skills. First, it has created an emphasis on workers being able to have flexible job skills since these individuals may be required to operate a wide variety of machines depending on what product is being manufactured. Second, it requires

employees to be responsible for ensuring that the quick set-ups take place accurately, thus ensuring that a minimum of product reworking is required. This has corresponded with the decentralizing of responsibility for production to the workstation. Companies using forms of work organization such as quality circles cited examples of teams of employees who had worked together to redesign elements of production to facilitate quick set-up.

4.2.3 Statistical Process Control (SPC)

Statistical Process Control (SPC) is a mathematically-oriented method of improving quality in the manufacturing process. It is a system of on-line inspection of semi-finished products, where production and quality control people are one and the same.

A number of companies have introduced SPC programs and courses for production employees to ensure improved quality control of the production process. Strictly speaking, SPC is more a method of feedback and monitoring than a 'technology' and as such does not directly increase productivity so much as it provides a mechanism to monitor problems in the production process as these occur. In some manufacturing environments visited, the statistical sampling of parts production was monitored and displayed to workers electronically. One difficulty production workers have with SPC is that when a fault is found, its source may not be at the workstation, but in a previous stage of production.

Adoption Rate

The use of SPC does not appear to be widespread in the electrical and electronics industry. Only 23 percent of respondents reported its current use, compared with 81 percent in the Canadian automotive parts industry according to a recent study. Although most current users anticipate greater utilization of

SPC in the future, very few non-users plan to introduce it by 1990. By that time, the cumulative adoption rate is expected to be 27 percent. The adopting firms, while mainly medium-to-large in size, represent all sectors except radio and television manufacturers.

Impacts on Skills and Occupation Requirements

The use of SPC is another example of a technology which requires employees to have basic numeric and interpretive skills. Electronic displays showing average line speed, capacity utilization and rejection rates must be read and interpreted by those close to the process. SPC may lead to the need for fewer inspectors, as the monitoring and quality control is an on-going process performed by the workers themselves.

4.3 Impacts of Technology on General Office Skills

The same drive for improvements in productivity which are in evidence on the shop floor is also affecting office employees. Personal computers, computerized financial systems and word processing are features of most company offices and their adoption is expected to continue. It can often be a company's most challenging process change, even more so than on the production floor. Management and clerical staff have had to become computer literate, as many office functions are now computer-based. For example, the computer is now used for word processing, filing, order taking, inventory control, accounts, personnel, and reporting.

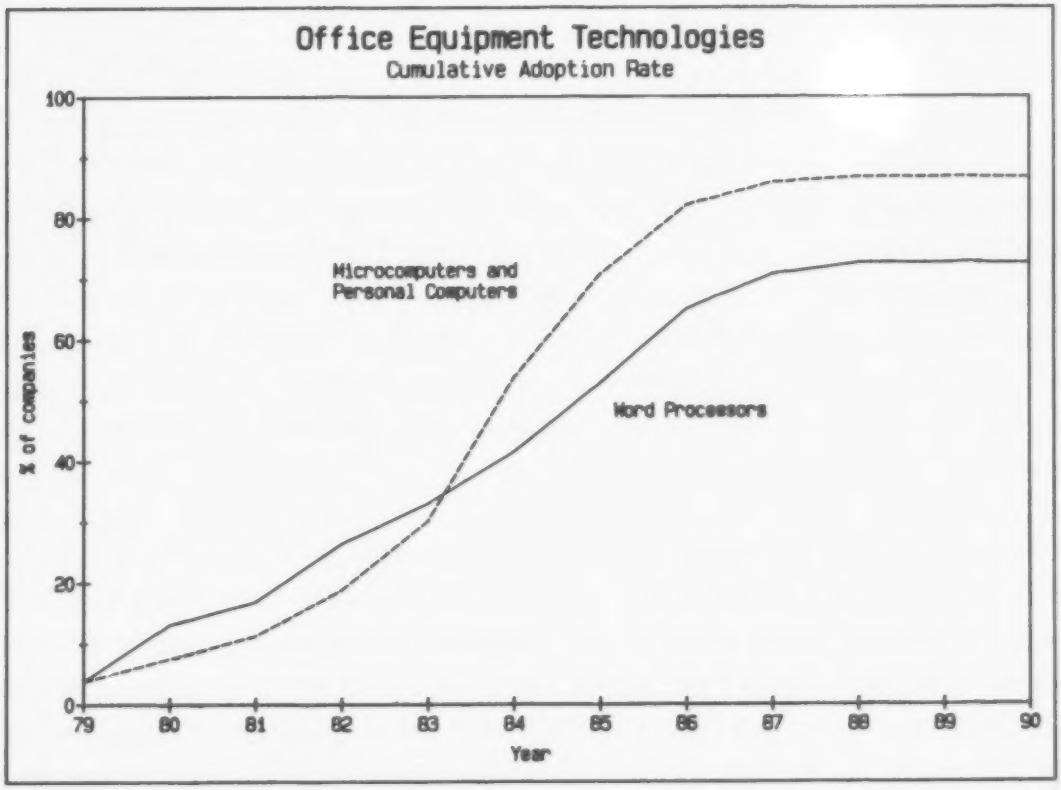
The impact of the computer in the office occurs in essentially two ways. First, the technology allows individuals to perform their own clerical and office tasks more efficiently. Second, using computer networks provides the ability to integrate information effectively from separate parts of the organization which management can then use for planning and control purposes. In its purest form, this leads to the fully automated office or, as the different components of

the organization are increasingly linked by the computer, to 'computer-integrated manufacturing' (CIM).

4.3.1 Microcomputers, Personal Computers and Clerical Tasks

The computer in the office affects productivity in a number of ways. It increases both professional and clerical staffs' ability to perform clerical tasks (e.g., word processing, record keeping, filing, etc.) and reduces the need to spend time on routine or time consuming activities (e.g., payroll administration). Most of the industry has micros and word processing equipment or expects to have these within the near future.

Figure 4.6



The computer also improves the ability to organize information quickly in a format which is useful for management. Computerized financial systems and automated payroll systems help reduce the time requirements for clerical and bookkeeping duties.

Adoption Rate

Both word processors (WPs) and personal computers (PCs) had been adopted by only 4 percent of companies in the industry prior to 1980 (see Figure 4.6). Until 1983 the introduction of WPs exceeded that of PCs, however, now the situation is reversed. This may be because PCs have become less complicated, less costly, and have adopted more functions over the past few years, including communications and word processing capabilities. By 1986, 60 percent of respondents were using an average of 21.8 personal computers, the most intensive use of any of the technologies listed in the survey. The cumulative adoption rates are expected to soon peak above 85 percent for PCs and 70 percent for WPs. The 'small' firms have been the slowest in adopting these office technologies.

Impacts on Skills and Occupational Requirements

The prevalence of PCs in the office has meant that many in management positions are having to learn word processing and basic computer skills. Many graduates of educational institutions now have these skills. Secretarial staff will likely have to upgrade themselves by learning the features of various hardware systems and software packages. They may have to become familiar with the full capabilities of these systems rather than just having to type quickly. As a result of these technologies, an individual's skills will increase although there is likely to be a reduction in the number of clerical and secretarial staff.

4.3.2 Integrated Systems and Networking and Their use in Management Planning and Control

There were several instances of respondents reporting two or more management planning, office equipment and telecommunications technologies that had

been installed as an integrated system. An example is the linking of a computerized financial system, word processors and a computer link between plants and head office.

These computer-integrated systems can quickly bring together disparate sources of data to produce reports to be used for management planning, control, and decision-making purposes. As a result, senior management can conduct improved plant-by-plant and product-by-product performance appraisals. By developing profit centres (groups within a company that can report on their own financial and operating performance), companies can see weak links forming before they become serious for the company as a whole.

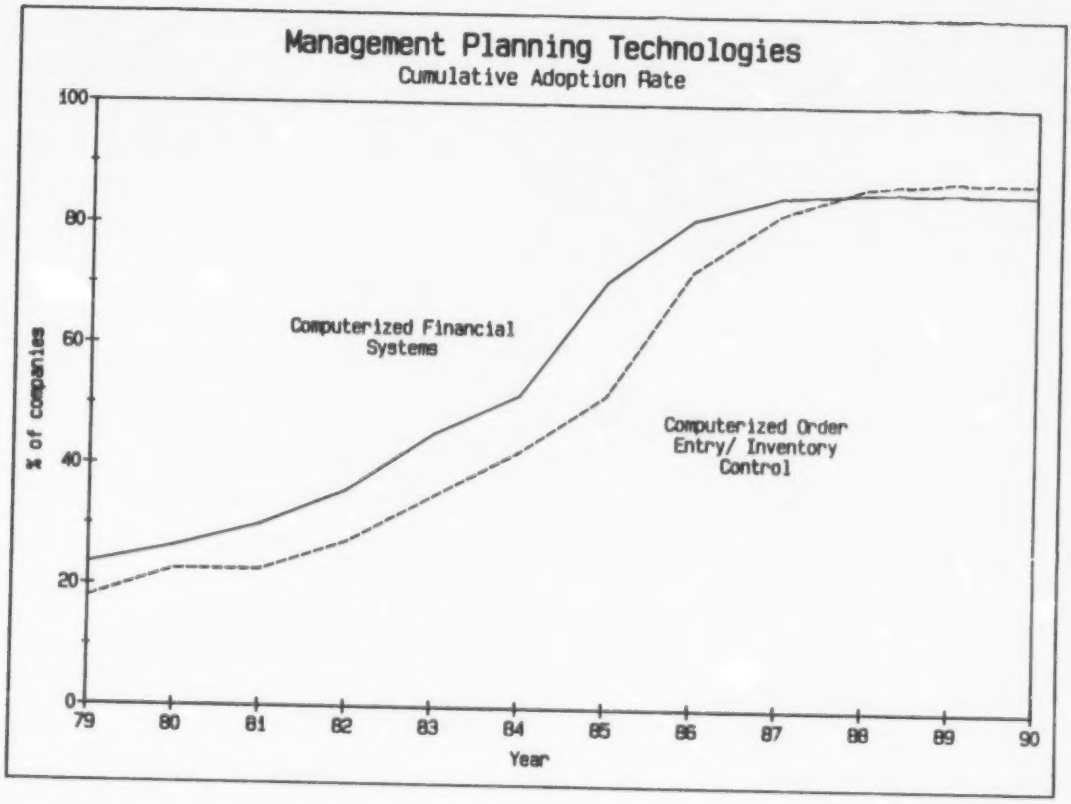
The integration of computer systems in the office itself may develop in a number of directions. For example, a number of companies now have computer links between their head office and plants and a few have linkage with customers and/or suppliers. Most companies expect that these linkages will become more commonplace over the next few years.

Adoption Rate

The first two technologies discussed below, computerized financial systems and order entry/inventory control, have high levels of penetration throughout the industry. They are presented in Figure 4.7. Computerized financial systems were the most widely adopted technology by 1980, when 24 percent of respondents reported its use. By 1986, the level of adoption had risen to 79 percent, second only to microcomputers. However, new introductions of financial systems end abruptly as no companies plan to introduce them after 1987. This technology is being used in all sectors by 1986, and most companies expect to maintain or increase current levels of use. About 80 percent of the current users are 'small' and 'medium'-sized companies. Most of the industry now has computerized financial systems or will have in the next few years.

The use of computerized order entry and inventory control technology is expected to be one of the most pervasive by 1990, with an anticipated cumulative

Figure 4.7



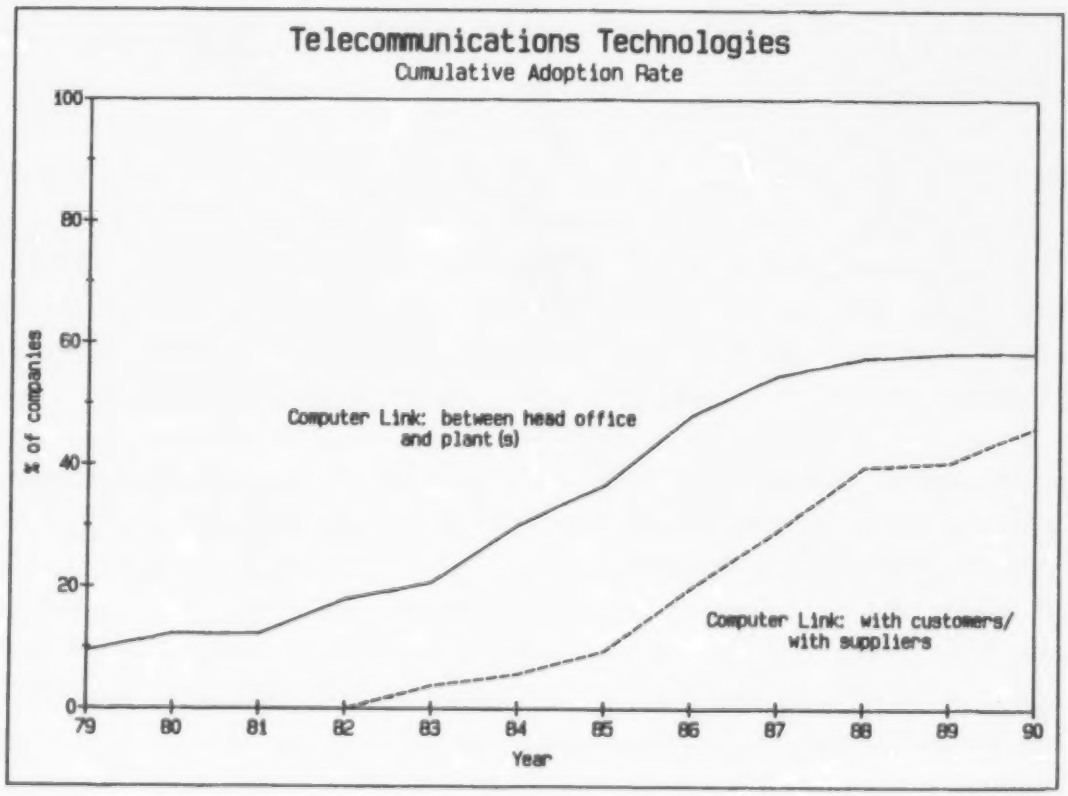
adoption rate of almost 90 percent, well above the 1979 adoption rate of 18 percent. The technology is presently being used in all sectors and spread across all sizes of companies, although it is concentrated in the 'small' and 'medium' categories. The majority of current users anticipate greater use in the future, and firms in all sectors plan to introduce this technology by 1990 with the exception of the office and store equipment and radio and television sectors.

The use of a computerized link between head offices and their divisions or plants is relatively widespread in the industry (see Figure 4.8). By 1986, 46 percent of respondents had adopted it, and an additional 15 percent plan to adopt it over the next four years. All sectors and all company sizes are represented in the sample. While almost half of the current users plan to increase their use of internal computer links, two companies indicated that they will phase out its use in the future.

Figure 4.8 clearly illustrates that no companies were using computer links with suppliers prior to 1980 and only 8 percent of respondents had adopted it by 1986. All current users, however, plan to increase its use in the future. Also, a number of current non-users will adopt computer links with suppliers by 1990, bringing the cumulative adoption rate to 23 percent. It should be noted that the adoption curve does not flatten out near the end of the forecast horizon, indicating that use of this technology may grow much more in the 1990s. Only major appliance manufacturers do not plan to use this technology before 1990.

The initial use of computer links with customers was in 1983, and by 1986 it had only been adopted by 7 percent of respondents. Future adoption plans, typically by 'medium' to 'large' firms, are expected to bring the penetration rate to 25 percent by 1990, similar to that of computer links with suppliers. Only radio and television manufacturers have no plans to introduce this technology by the end of the decade.

Figure 4.8



Impacts on Skills and Occupational Requirements

As with other office-based technologies, there will be a requirement for staff to have more familiarity with computer operation. Further, all these uses of the computer in the office environment have the cumulative impact of doing more work with fewer employees. In one case, the number of clerks in an administration department was cut in half by the introduction of an integrated computer system. Manual clerical work was cut from 60 percent to 20 percent of total job time. As with the implementation of a new technology on the shop floor, employees are not always being displaced at a rapid rate. Generally, companies reported much greater reductions in administrative employment as a result of cutbacks and attrition during the recession as opposed to employment loss directly attributable to technological displacements.

While we are not seeing any examples of computer-integrated manufacturing in its purest form, the introduction of the computer has had the effect of reducing the need for certain clerical and middle management staff. This in turn has led to 'flatter' organization structures and less hierarchy. As a result, some companies pointed out that there are fewer opportunities for promotion or increases in remuneration and therefore companies are increasingly being faced with the problem of how to motivate and reward their employees as the traditional avenues are no longer open to them.

4.4 Material Handling and Inventory Control

In addition to 'hard' technologies, 'soft' technologies and office technologies, there are other techniques which help improve manufacturing efficiency and product quality. These include enhanced inventory management systems, material requirements planning, and automated warehousing, and are presented in Figure 4.9.

4.4.1 Just-in-time Delivery, Manufacturing Resource Planning, Automated Warehousing

Most companies reported increasing use of 'just-in-time' (JIT) inventory systems. Just-in-time delivery is a concept involving the delivery of parts and

components at specific times just as they are needed and in no more than the quantity required. Companies are using these methods in response to the need to cut inventory carrying costs and to respond rapidly to changing product specifications in response to customer needs.

Companies are also adopting material requirements planning (MRP) systems. MRP systems involve the computer integration of the production plan with the bill of material and inventory records to produce the materials requirement plan. MRP2 (manufacturing resources planning) is an extension of MRP, involving the further integration of the financial and business planning systems with the material requirements system. This allows for better integration of the planning process with the inventory management function. About 50 percent of the industry has some form of MRP and the rate of adoption of this technology is expected to increase to about 80 percent of the industry by 1990.

The emphasis on JIT delivery and MRP systems is creating a demand for products from parts suppliers which are of high quality since a problem with a part can interfere with or halt a production run. This in turn has forced a close relationship between manufacturers and components suppliers to ensure necessary standards of product quality. One manufacturer reported that it used its engineers to work with a component manufacturer to isolate a problem in their manufacturing process. Other companies expect to develop computer linkages with their components suppliers in the next few years.

The warehousing and inventory management systems have become increasingly sophisticated and are themselves becoming subjected to technological developments and automation. For example, the marking of parts with bar codes, the reading of these with electronic instruments and translating this information using computers and the appropriate software is beginning to replace what traditionally have been manual systems. Similarly, although not as widespread, companies are increasingly mechanizing the warehousing function through the adoption of automated storage and retrieval and materials transfer systems.

These technologies have also created a market opportunity which some companies in this sector have developed and exploited quite successfully. One

fast-growing company interviewed markets a parts management system which it had originally developed for the aerospace sector to deal with this sector's complex parts management requirements.

Adoption Rate

One company commented that it had been using JIT in one form or another for decades and that it is the only way that a small company can function profitably. Contrary to this view, only 4 percent of respondents reported they were using this technology by 1980. The proportion of use grows to 33 percent by 1986, due mainly to adoption by 'small' and 'medium' companies.

Although one company anticipates decreased use of JIT delivery from suppliers after 1986, a significant number of firms plan to introduce JIT with either their customers or their suppliers. Penetration is anticipated to reach 60 percent by 1990. It is noted that almost all future plans involve the adoption of JIT from suppliers. There is no adoption of JIT delivery to customers after 1987.

By the end of the period, no radio and television manufacturers plan to introduce either form of JIT, while major appliance and wire and cable manufacturers do not plan to introduce it for customer deliveries.

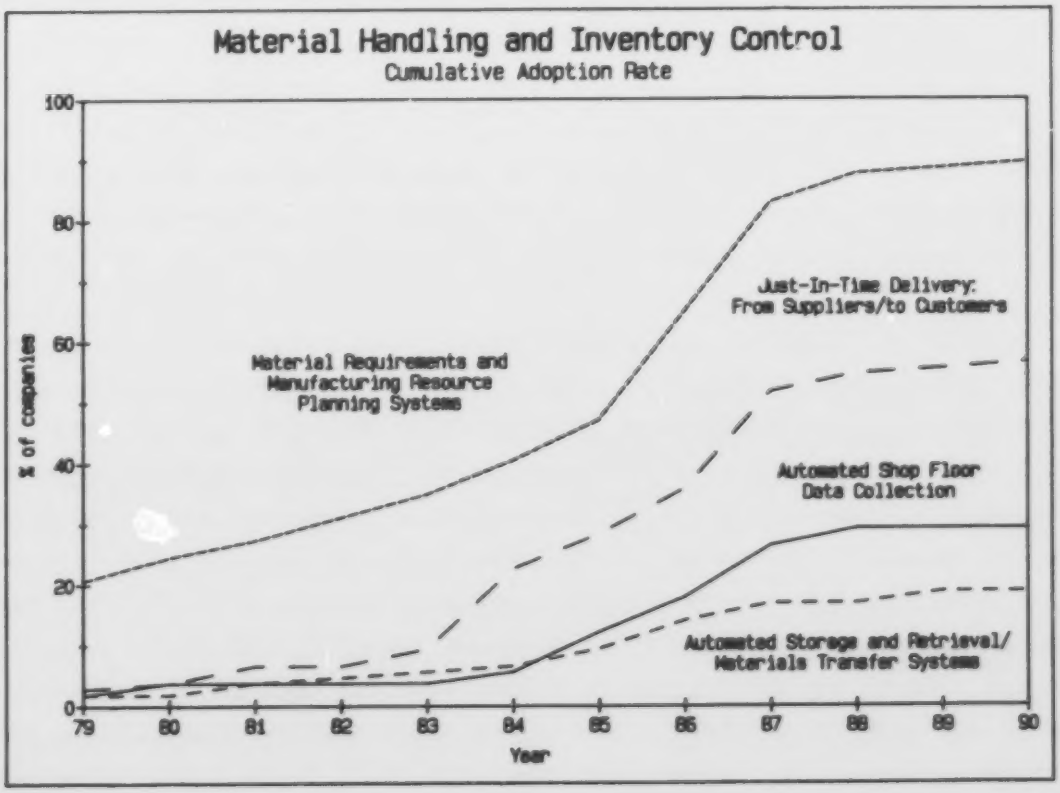
Respondents in all of the sectors adopted MRP by 1986, with over 50 percent being 'medium'-sized firms. Although the current use of the system is high (41 percent of respondents) and the majority anticipated an increased use of MRP in the future, it is one of three technologies that some firms expect to phase out. Almost 5 percent of firms responding plan to phase out MRP by 1990. A reason for this could be that MRP takes detailed planning to successfully introduce it into the work place. As much as five years may be required to plan, implement and bring it to maximum operating efficiency. Firms that start the process may not be able or willing to follow through to completion and, as a result, drop it entirely. In spite of the discontinuations, 19 percent of respondents plan to introduce MRP over the next four years, bringing the

cumulative adoption rate to 60 percent in 1990. All sectors except major appliance and wire and cable manufacturers will be represented.

Although MRP2 is an extension of MRP, 11 percent of firms that listed MRP2 in their adoption plans over the 1980s did not report the previous use of MRP. Conversely, only 40 percent of companies that had listed MRP had then installed, or planned to install, MRP2. The expected cumulative adoption rate is 34 percent by 1990, again focused on the 'medium'-sized firms, and distributed across all sectors except major appliance and radio and television manufacturers. Of the 20 percent who are using it presently, all plan to expand MRP2 utilization in the future.

The adoption rates of MRP and MRP2 are added together in Figure 4.9 with a combined penetration rate of 93 percent by 1990.

Figure 4.9



Although the proportion of the industry that will have adopted automated shop floor data collection technology by 1990 is expected to be only 32 percent, the distribution covers all size categories and all of the sectors except major appliance manufacturers. The adoption rate is relatively flat except for a period of rapid adoption between 1984 and 1988.

Only 4 percent of respondents, with a total of 14 units, reported using automated storage and retrieval technology by 1986. Users are mainly those in office and store equipment, communications, and scientific instrument industries, across all size groups. All of these companies are expected to maintain or increase their current use of this technology. An additional 4 percent of firms in the lighting fixtures, electrical industrial equipment, and miscellaneous electrical products sectors plan to adopt it by 1990.

Automated materials transfer systems technology has a higher adoption rate than automated storage and retrieval, at 8 percent of respondents in 1986. (They have been combined in Figure 4.9.) However, its use is more limited when ccmpared with other technologies in the industry. There were 27 systems in use at the time of the survey, with the majority of respondents indicating future plans to increase its use. The sectors using automated materials transfer systems are the office and store equipment, small appliance, communications, miscellaneous products and scientific instruments manufacturers, with a concentration in the 'medium' and 'large' size groups. Another five percent of respondents in the lighting fixtures, electrical industrial equipment and miscellaneous electrical products industries have plans to adopt this technology in the near future. Only the major appliance and radio and television sectors have no plans for materials transfer technology by 1990.

Impacts on Skills and Occupational Requirements

As with other technologies, the use of and familiarity with computers will increasingly be required. In some cases, the introduction of JIT, MRP and automated warehousing has created a slight reduction in the need for warehouse

personnel. It is likely that as the technologies become more prevalent, there will be continued reductions in the need for warehouse personnel.

4.5 Managing the Implementation of New Technologies

It is clear from the personal and group interviews conducted that most employees are eager to accept new technology if it means expanding their knowledge and skills. Most have an inherent desire to learn and progress. Change, therefore, is not seen as a problem, instead it is the process of change that is the cause of most difficulties. When new technologies or management techniques are introduced, there are many instances where poor planning, implementations or training lead to wasted efforts, undue fears, and unfulfilled expectations. In one case, an integrated system was implemented piecemeal and in sub-optimal order, making the changeover process unnecessarily difficult. In another case, a new and an old system were not run in parallel. When the new system encountered difficulty, the problem had to be fixed manually and production was halted. Another system was not properly introduced to employees, generating a fear of computers and a feeling of 'lack of control'. As a result, the employees tended to work against the new system, making the implementation more difficult.

4.6 Summary Findings and Conclusions

1) Adoption Rates Vary Across Technologies

The need to adopt new technologies has been driven mainly by the need to improve speed, product quality, and productivity, in order to improve the industry's ability to remain competitive, both domestically and internationally. The adoption of the technologies mentioned in this chapter has been uneven across both the sectors and the different company size groups in the industry.

The survey results indicate that the most widely adopted technologies in the electrical and electronics industry by 1990 will be microcomputers, computerized financial systems and order entry/inventory control, and the combination of MRP

and MRP2. This implies that computerized administration appears to be the initial focus for technological change for most of the industry. Contrary to this, though, is the fact that computer links between head offices and their divisions, as well as with suppliers and customers, do not enjoy very wide usage.

There has been relatively rapid adoption of CAD since 1983, but none of the other design technologies are being implemented to a large degree. Similarly, the pace has picked up for the work organization technologies such as self-managing work groups, leading to a certain degree of organizational innovation.

The rates for 'hard' technologies, such as robots, have been relatively steady but not very rapid. Companies perceive these as becoming more prevalent in the long term, between 5 and 20 years, which is outside the range of the survey sample. The process technologies, such as SPC and quick tool and die change, experience the lowest levels of adoption and interest does not appear high to change this in the future.

It is apparent from the survey results that the rate of initial adoption of new technologies is slowing. This may indicate that firms that are most likely to begin using a new technology have already done so. But it is also quite likely that there is a great deal of uncertainty in the industry and companies are unable to forecast their technological requirements, even for the few years before the end of the decade.

2) The Organization of Work is Changing

Responsibility for quality control and production management is increasingly being passed to the individual workstation. Examples of these decentralized forms of work organization include self-managed work groups, quality-of-working-life programs and quality circles. These are being developed to facilitate flexibility of production and to improve productivity by encouraging employees to become more responsible for control and monitoring of the production process and the diagnosis of problems on the shop floor.

The introduction and linking of computers in the office and on the shop floor, together with automated production and the need for quality enhancement, are tending to flatten company hierarchies. Companies are giving increasing attention to new ways of motivating workers given that many of the traditional avenues such as advancement in the corporate hierarchy will be less available. Although small businesses appear to be behind in the adoption of some of the new production methods, they are quicker to use improved human resource management techniques such as decentralized forms of work management and organization, which are relatively inexpensive to adopt but very effective in improving productivity. These benefits are available to larger firms if they can overcome their typically larger and less flexible management structure.

3) The Impact of Technology on Employment Levels

Changing technology has had a dramatic effect on the kinds of jobs people do. The introduction of new technologies at some companies has considerably reduced employment levels. For others in some of the more mature sectors of the industry, technology may have had little impact on job skills or employment levels. Most companies reported that market developments and the resultant industry reactions, such as layoffs, acquisitions and mergers, reduced employment levels much more dramatically than the adoption of new technologies. In this respect, technology has tended to be evolutionary rather than revolutionary in its application and its impacts on employment.

Conclusions

The industry needs to assess the implications of the current adoption rates and future levels of penetration for remaining competitive and to meet the growing international component in the industry. Factors to concentrate on are product quality; diversity and deliverability; the suitability to customer needs; flexibility and adaptability of the company in general, and the production process and employees in particular.

- The industry and government must encourage investment in both capital equipment and training in the new technologies in order to remain competitive in an international environment.

- Existing skills of those now employed in the industry must be upgraded as a result of the introduction of new technologies, changing work organization and changing responsibilities.

5. CHANGES IN SKILL REQUIREMENTS AND OCCUPATIONAL PROFILE

5.1 Changes in Design and Production Skill Requirements

5.1.1 Evolution of Technologies

There has been an evolution in generations of technology from analogue to digital technologies, from electromechanical technology to electronics. These evolutions have created a need for workers with essentially different skill sets, and, therefore, training requirements. The impact of technologies such as CAD/CAM are affecting the traditional way products are designed and the way tools are made. Traditional lines of demarcation between designers and tool makers are breaking down - leading on the one hand to a much greater need to understand and be trained in new techniques - but on the other hand leading to a certain 'down-skilling' of traditional craftsmanship. This chapter expands on certain issues raised in Chapter 4, as well as introducing new concepts related to skills and the occupational profile in this industry.

5.1.2 The Down-skilling Debate - Workers are Increasingly Having to Work in a Controlling and Analytical Fashion

Some manufacturers are beginning to implement CAD/CAM and robotics systems and in some instances, they are having a dramatic impact on skill requirements. In the discussion groups held with production employees, a number of skilled tradesmen such as tool and die makers and mould makers reported that the introduction of CAD/CAM had changed the nature of their work. Some of these individuals felt that aspects of what used to be their job were now being performed by these machines. For example, parts of the tooling, mould making, and machine set-up processes were now being performed by the computer. This phenomenon was referred to as 'de-skilling' or 'down-skilling' since these skills were formerly carried out by the workers themselves. In some respects, these individuals felt that much of the 'craftsmanship' associated with their trades was now disappearing. They perceive that the role of the tradesman is being transformed from skills associated with hands-on production to more of a monitoring and controlling function.

5.1.3 Basic Skill Requirements

In contrast to the notion of de-skilling, some individuals argued that the change in the nature of the job referred to above created the need for new job skills and that these may require higher or lower skill levels than what had formerly been the case. For example, in order to monitor the machines and to program them effectively, a certain level of literacy and numeracy (i.e., the ability to understand and manipulate numbers) was required that may not have been the case under the traditional system. Further, as responsibility for quality is decentralized to the workstation, production employees are increasingly being required to monitor the quality of the products being manufactured and to diagnose problems or suggest product or process improvements. Good communication and analytical skills are therefore becoming increasingly important.

To fully understand the new sophisticated equipment, it was pointed out that an appreciation is required of the basics of computers and statistics. This applies both to the production process and in the office. This kind of training may not necessarily be part of the retraining provided by an employer.

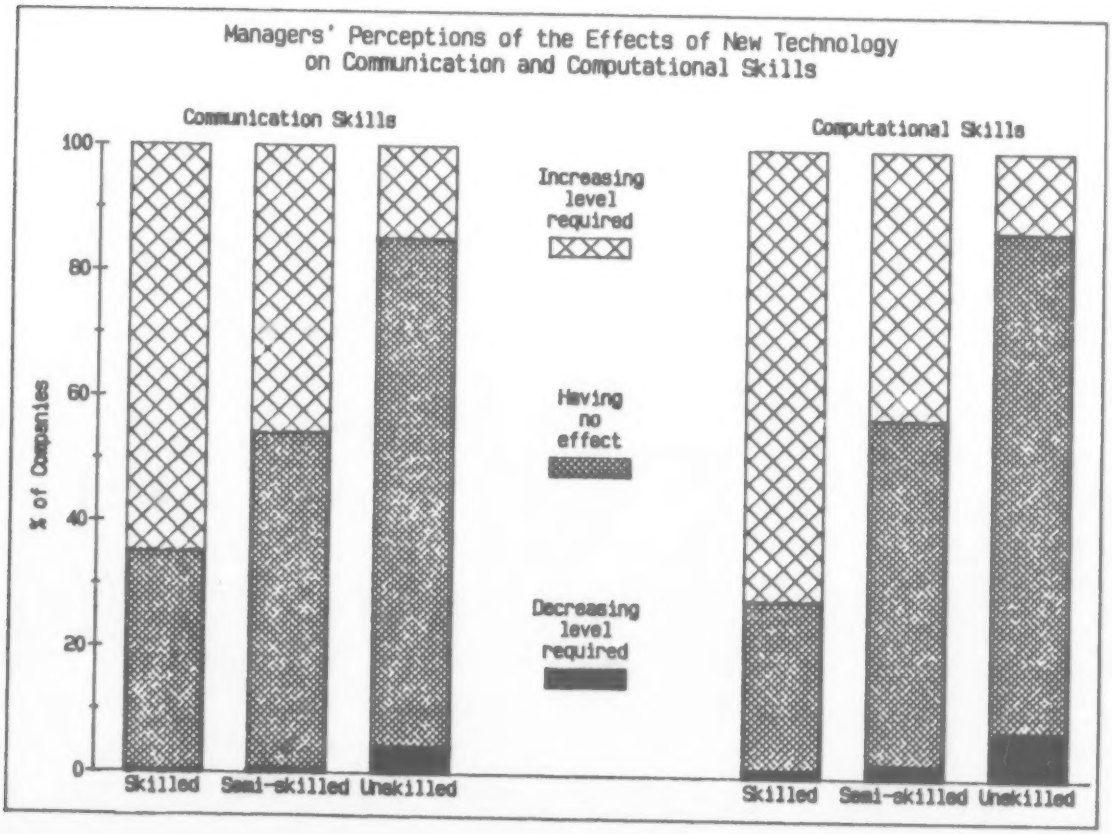
Respondents to the survey were asked to evaluate the level of basic communication and analytical skills of their work forces, and were asked to distinguish between the skills of new entrants and those of experienced workers. The responses were made on a share basis, listing the percentage of workers which fall into one of three groups: less-than-adequate skills, adequate skills and more-than-adequate skills.

In general, companies see the basic skills of the majority of their work force to be adequate or better. Yet, over half of the respondents feel that some portion of their experienced workers had less-than-adequate skills. This share is between 35 and 40 percent for the new entrants. It should be pointed out that the portion of a firm's work force perceived as inadequate was typically 25 percent or less. Very few respondents believed that the majority of their workers were lacking in basic communication and analytical skills.

Generally, a higher share of experienced workers were seen to have inadequacies in these basic skills when compared with the new entrants. But both of these groups were seen to have a greater problem with their communication skills relative to their analytical skills. Firms also stated that older workers had a larger share of less-than-adequate skills.

Companies were also asked to give their views concerning the effect technological change was having on these basic skill requirements for skilled, semi-skilled and unskilled workers. As expected, technological change has made communication and analytical skills more important for the work force, particularly for the higher skill occupations (see Figure 5.1).

Figure 5.1



5.1.4 Production Workers are Required to be Increasingly Flexible and Responsible for Quality Control

Companies are being faced with increased demands from customers on product quality, deliverability, and suitability. Because of shorter production runs and because many companies today report they are unsure as to what they will be manufacturing in the not too distant future, employers are seeking more flexible and efficient design and production methods. Increased automation is one approach. Employers are also trying to increase the flexibility of their work force. Demands for flexibility are thus being passed down the line from the customer to the employee.

Further, shorter production runs will require short set-up times and a minimum of reworking in order for products to achieve profitability quickly. These needs for high production speed and quality will both fuel the trend to increasing automation and create the need for an increasingly flexible and quality-oriented work force at all levels in the organization. In some companies, relatively unskilled and semi-skilled production workers will have to be familiar with two or more jobs. The equipment or machinery being operated is likely to be considerably more sophisticated than what has traditionally been the case.

5.2 Changes in Office Skill Requirements

As technology has changed skill requirements on the shop floor, it has also caused changes in skill requirements in the office. Design and production technologies are creating a demand for different types of skills amongst engineering and design staff for whom the computer is increasingly an important design tool. Managers and clerical staff are increasingly expected to be computer literate and this has been a difficult adjustment for employees with limited exposure to these technolcgies. New office-related technologies often require that training be provided by hardware or software vendors. Sometimes this training is also provided by third parties (e.g., consulting firms) or tutorials may be built directly into the software packages. Some companies report that they have experienced more difficulty upgrading staff in the office than they

have in the production or manufacturing areas of the firm. As with the implementation of technologies on the production side, it is very important that effective training and needs analysis is carried out as employees must be convinced that the technologies will help them if a computer system is to work effectively. This is particularly important since office technologies are often implemented as a system rather than as separate units.

5.3 The Implications for Training

5.3.1 Most Companies Retrain Rather Than Hire From Outside

When confronted by new job requirements created by new technology, about 60 percent of the industry retrains existing workers, 10 percent hire from outside the company and about 30 percent do both. Most companies attempt to fill any gaps from within before going to the outside job market. Some companies have highly formalized in-house training programs whereas others expect employees to learn on the job, with or without supervision.

Although employers appear to favour the retraining of existing staff for new technologies, cost and skill practicalities can cause problems. A dilemma for management is that some older employees with higher wages may not adopt new production methods as readily as younger low-wage employees. A response in the past has been to wait for company growth to alleviate the problems. This method, however, is no longer suitable, especially for low-growth environments, and can be a source of contention between labour and management. The occupations where the greatest retraining is taking place are high-skilled assemblers, technicians, service representatives, engineers, lesser-skilled assemblers, sales representatives and managers. Retraining or upgrading of workers is usually conducted in-house. A smaller proportion use training by the vendor of the new technology, sometimes in conjunction with a community college.

5.3.2 The Age Profile of the Work Force

In some instances where the relatively older age of the production work force is a cause of concern, younger workers are reported to be more flexible in the sense that they are willing to make changes in their jobs and more likely to stay up-to-date on emerging technologies.

Technological changes appear to cause the most upset among older workers in plants - generally those who are more accustomed to traditional electro-mechanical and analogue technology. Such employees in their forties and fifties who have not been educated in modern electronics and are often in supervisory positions, feel threatened by younger entrants who are more familiar with the new technology. There is often more reluctance to upgrade because they may feel, 'Is it worth it at my age?'

But there are also instances where the older workers realize that they must be updated on new technologies to ensure their employment and are quite willing and open to learn the new techniques.

The age profile of the work force in the electrical and electronics industry is presented in this section in two different forms: an occupational breakdown using the 1981 Census, and a breakdown by sector based on 1985/86 data from the survey results. The data based on the 1981 Census admittedly is somewhat out of date but it can be useful for observing general trends. A comparison of the distribution of total employment across the same age categories between the two data sources is shown in Table 5.1.

Table 5.1
Proportion of Total Employment by Age Group

Source	15-24 Years of Age	25-54 Years of Age	55 Years of Age and Older
1981 Census	21%	67%	12%
Survey	10%	80%	10%

As the table illustrates, there is a significant difference of 11 percent in the younger age group between the two data sources. This is captured mainly by the middle group. There are a number of plausible reasons for this phenomena. Total employment in this industry declined dramatically from 1981 to 1983, and there has been a very slow recovery since. Presumably, this has had negative impacts on the number of workers employed in the younger age group, since it is likely that the necessary reductions in employment would be achieved mainly through layoffs of the younger, less experienced portion of the work force. In addition, there would have been limited opportunities for younger people to enter the job market in this industry. A portion of those in the 15-24 age group in 1981 will have moved into the 25-54 age category by 1985/86. These points, coupled with the fact that the share of workers in the older age group is virtually the same, indicate that once the 1981 Census results are combined with changes in the industry between 1981 and 1985/86, the survey results appear to be representative of the industry as it currently stands.

Age Breakdown by Occupation

This section examines the distribution of the work force by age across the main occupations in the electrical and electronics industry. The average age for total employment in this industry is 36.7 years (male, 37.6; female, 35.2). Table 5.2 shows the distribution of the work force, by occupation, across three age categories: 15-24 years of age; 25-54 years of age; and 55 years of age and over.

The top five occupations with a large share in the older age group, excluding guards and janitors, are tool and die makers, supervisor-sales, general managers, industrial engineers, and industrial mechanics. An implication of a relatively high proportion of workers in the older age group is a heavier demand on recruitment requirements as these people retire.

There are also implications when there is a relatively low share in the older age group. Occupations that have less than 5 percent in the '55 and over'

Table 5.2

Age Profile of the Electrical and Electronics Manufacturing Industry Workforce by Occupation

Occupational Group	Age 15-24 %	Age 25-54 %	Age 55+ %
Sales Management	3	82	15
Production Management	4	80	16
General Managers	0	77	23
Other Management	4	84	12
Electrical Engineers	8	79	13
Industrial Engineers	5	74	21
Mechanical Engineers	9	75	16
Draughtsmen	21	71	8
Engineering Technologists and Technicians	28	63	9
Systems Analysts	20	77	3
Other Engineering and Technical Occupations	3	85	12
Secretaries	23	68	9
EDP Equipment and Office Machine Operators	33	63	4
Production, Shipping, Stock Clerks	26	61	13
General Office Clerks	36	53	11
Other Clerical	27	65	8
Technical Sales	11	72	17
Supervisor - Sales	8	66	26
Other Sales	12	76	12
Metal Extruding and Processing Occupations	21	68	11
Tool and Die Makers	12	51	37
Machinist	21	64	15
Welding	23	67	10
Other Machining	21	65	14
Fabricating and Assembling Occupations	23	67	10
Industrial Mechanics	13	69	18
Other Mechanics/Repairmen	5	95	0
Electrical/Electronic Equipment Installing and Repairing Occupations	20	72	8
Material Handling Occupations	27	64	9
Guards	19	32	49
Janitors	23	45	32
Total Work Force	21	67	12

Source: Special Tabulation, 1981 Census, Statistics Canada

category are systems analysts, office equipment operators, and other mechanics and repairmen. In some cases, a low share is a reflection of the characteristics of the occupation itself. For instance, it could be a relatively new occupation, such as systems analyst, so there has not been enough time for workers to move into the older age groups.

It is also possible that an occupation is such that as people get older and gain experience, they move into a different area (e.g., move out of sales and into management), and so there will always be a below-average share in the older age group. Alternatively, a relatively small share in the older group could reflect opportunities for advancement within that occupation and a relatively large pool of younger people to build upon, with minimal requirements for training over and above that which comes with experience.

As one would expect, the majority of workers, at an average of 67 percent of total employment, are captured in the 25-54 age group. If there is less or more than average in this age group, it is necessary to consider the occupation as a whole, observing the remaining shares in the younger and older categories, before drawing any conclusions.

A high concentration in the younger 15-24 age group may be indicative of a relatively new occupation, implying above average demands for training. In this industry though, most of the occupations with a high concentration in the younger age group are lesser-skilled, such as general office clerks, office equipment operators, material handling occupations and shipping clerks. These are entry types of occupations and are expected to have a larger share of young people. Workers in these occupations often move into other occupations as they gain expertise.

Engineering technologists and technicians had an above average share of 28 percent in the 15-24 year age group in 1981. This is an occupation where most workers start in an entry level position and usually require a significant amount of training to adapt the general knowledge learned in college to the specifics required by the company they work for. The below-average shares of

workers in the middle and older age groups for this occupation may reflect a re-classification of technicians into categories considered more as engineering or management as they gain expertise. Alternatively, it may be that certain jobs that fall under this occupational group are relatively new and the high share of younger workers will be working their way into the older groups over time. Of course, from the workers point of view, a large share such as this may indicate limited opportunity for entry at the time, but better opportunity in the near future as advancement occurs. There may also be a high degree of competition both at the hiring stage and during employment, depending on the levels of supply.

It is interesting to note that both the welder and assembler occupations had a share of workers in the 15-24 age group that was above average in 1981. This could be a reflection of the fact that automation had not affected the hiring of these types at that time.

A low proportion in the younger age group in an occupation may indicate a potential future problem of a lack of supply of qualified personnel from the industry's point of view. There may be a need for serious recruitment efforts, with the consequent training requirements, to ensure a pool of workers to draw upon for advancement and the continued viability of the occupation.

This interpretation may apply to the mechanics occupation which has below-average shares in the younger age category. In addition, a problem could be developing here because of the movement towards electronics in the production process. The requirements for recruiting mechanics with this background will increase. At the same time, a major movement to retrain the existing workers, concentrated in the middle age group, will be required to bring them up-to-date on repairing equipment based on the newer technologies. For the workers, a low proportion in the young age group may highlight job opportunities in a certain occupation.

A share below average in the 15-24 age group may also be related to slow or declining employment growth in the industry as a whole. On the other hand,

it may be an occupation that requires a certain level of expertise not usually acquired before accumulating several years of experience. Examples of this are the management occupations - sales, production, general and other - as well as industrial engineers, all of which have a share of the younger age group that is less than 5 percent.

Age Breakdown by Sector

Although there is no occupational breakdown from the survey, there is a distribution by sector. This is presented in the following table, which includes a finer breakdown of the 25-54 years age category than was available from the 1981 Census. It is interesting to note which of the sectors reports the highest and the lowest shares of workers by age group relative to the other sectors, as this may reflect historical employment trends or it may be indicative of the level of maturity of the industry itself.

Table 5.3

Age Profile of the
Electrical and Electronics Manufacturing Industry Workforce
By Sector

	Less than 25	25-34	35-44	45-55	55+
Office, store & business equipment	16.9%	40.1%	27.9%	10.9%	4.2%
Small appliances	5.7%	19.3%	28.0%	26.5%	20.4%
Major appliances	4.2%	28.3%	34.9%	22.1%	10.6%
Lighting fixtures	12.4%	27.0%	35.5%	17.7%	7.4%
Radio & television receivers	10.6%	28.7%	30.5%	19.4%	10.9%
Communications equipment	9.4%	31.9%	28.1%	22.2%	8.4%
Electrical industrial equipment	7.6%	32.9%	27.5%	17.5%	14.4%
Electric wire and cable	7.1%	30.0%	25.7%	22.6%	14.7%
Miscellaneous electrical products	12.3%	30.4%	27.3%	18.8%	11.2%
Scientific instruments	8.4%	34.3%	27.3%	20.7%	9.3%
Total	10.0%	32.7%	28.0%	19.6%	9.6%

For example, the office and store equipment sector captures the largest share of employees in each of the younger age categories, with 57 percent of their workers being under the age of 35. As one might expect, it has the smallest share of workers in both age categories above 45. This is one of the industries most closely related to the newer technologies, particularly advances in computers, so it is not surprising that the workers are relatively young. In addition, it is one of the few sectors in this industry that did not experience declines in employment in 1982. There was a small decline in 1983, but the level of employment jumped back in 1984.

The small appliances sector reported that 47.9 percent of its work force is over 45 years of age, the highest of all the sectors, and it has the lowest share of workers in the 25-34 age group. Except for 1981, employment in this sector has been stagnant or declining since 1974, which may explain the relatively small shares in the younger age groups.

The major appliances industry, considered to be one of the more mature sectors in the electrical and electronics industry, has the smallest share of employees in the 'Less than 25' group. Total employment in this sector declined each year from 1979 to 1982, and again in 1984 after an increase in 1983.

In general, employment in the wire and cable industry has been declining since 1974, with an increase of only a few hundred in 1979 and 1981. This may have lead to the fact that it captures a relatively small share of the 35-44 group. Conversely, the lighting fixtures industry has the largest share of workers in the 35-44 age category. The employment level in this sector has fluctuated a great deal over the last decade, but the general trend has been downward.

In summary, there may be a cause for concern for human resource planners about the relatively low 10 percent share captured by the 'Less than 25' group as indicated by the survey results. This could translate into a lack of a pool of younger people to draw upon to advance through the ranks as they gain expertise. The mechanics/repairmen and tool and die makers occupations seem to be

particularly at risk to this. The situation for tool and die makers may be even more serious when one considers the high proportion of workers that were over 55 years of age in 1981. The scenario for mechanics and repairmen may be exacerbated by the movement towards the newer electronic technologies.

5.3.3 Ability of Training and Educational Institutions to Meet Current Needs

There is increased interaction between business and educational institutions. Many larger employers have some form of contact with universities and their local community colleges. But some employers were critical of universities - particularly of the need to develop leading edge research centres of excellence in electronics technology. The need for students to learn on advanced equipment at colleges and universities was also raised as a requirement that has not been met. They also saw the need for basic education in the schools in areas such as statistics, computers and mathematics as the driving force behind developing a technology literate work force. The number of electrical engineering graduates in the colleges and universities has been increasing in recent years (see Appendix IV) in response to the industry's needs. However, a number of problems still exist.

In many cases, employers need to provide training quickly and if local community colleges cannot supply it then employers have to turn to private vendors. Employers state that the time required for community colleges to respond to requests for new courses, establish the course and produce qualified graduates is in most cases much too long to be of any use. Employers recognize the financial restraints under which such institutions operate and comment that in the long run this leads to the use of out-dated equipment in institutions and less responsiveness on the part of colleges to work with industry in addressing specific training needs.

Technological developments can create the demand for skills far in advance of training and the educational institutions' ability to respond to these demands. For example, one company requires a small number of highly specialized individuals who have a combination of very specific skills. Persons with these skills

are not currently being trained by Canadian institutions. While this company did not expect that educational institutions would, nor necessarily should, supply these individuals directly, it does illustrate a general problem. That is, technological developments can create the need for a few jobs with highly specialized skills requirements that Canada's educational institutions may never be able to respond to quickly enough. Conversely, educational institutions may not be able to justify the development of a specialized training program.

Companies have difficulty recruiting individuals usually under one of the following sets of circumstances:

- Where new areas of expertise have been created by the developments of the technology itself (for example, the need for applied meteorologists was created by the development of new testing procedures and the associated equipment.
- Where new areas of expertise have been created by the combination of skill sets which traditionally belong to separate disciplines (for example, the need for individuals who are trained in what traditionally have been different engineering skills, or the need for production workers who combine skills belonging to what traditionally have been different trades or occupations).

In the former instance, one company was having difficulty obtaining immigration approval for a highly skilled engineer with experience in developing laser technologies in one of its overseas operations. The company believed that this scientist had the potential to develop new technologies and products which open up new markets and create employment in Canada.

5.4 Changes in Occupational Composition

5.4.1 Job Classifications are Changing

The cumulative effect of these technological changes is altering the meaning and the content of traditional job descriptions. For example, it is becoming difficult to use the terms 'skilled' and 'semi-skilled' in the traditional sense of

measuring the time necessary to become proficient in a job. The new technologies are reducing certain hands-on crafts or production-type skills and replacing these with the need for increased analytical, diagnostic and problem-solving skills. This is causing problems in some production environments as employees are often left to discover these changes on their own. Alternatively, production employees may view management's attempts to reorganize its work force or to reclassify positions as an attempt to reduce the compensation levels of the positions perceived to involve down-skilling, without concomitant recognition of the increase in different types of skill requirements for certain jobs.

5.4.2 Less Manual, Semi-Skilled, Administrative Employees

Companies reported that they perceived that in the future there will be a need for fewer manual, semi-skilled and administrative employees as these are the most exposed to displacement created by new technological developments. The demand for unskilled workers will decline. Many of the unskilled jobs are most threatened by technological change. These jobs can be replaced by relatively simple equipment which can do the work of product movement and material handling. Some of these jobs can also be replaced by more sophisticated equipment such as CAM and robotics. Assembly jobs are beginning to be supplemented by technologies such as wave soldering machines and robotics. While the introduction of robotics to displace assembly workers has not been extensive, further development has the potential to displace many of these jobs in the future.

The demand for administrative employees performing clerical, secretarial and middle management jobs may decline since they are being displaced by the computer which can perform word processing and data management functions, as well as assist in simple decisions based on data.

The survey did not identify any occupations that are likely to shrink dramatically. Requirements for machine operators in both the office and on the factory floor are expected to be roughly constant.

5.4.3 Increases in Technical, Design, Engineering, Marketing, and Sales

Increasing competition and the greater appreciation of customer needs have meant more product diversity, faster product development, more careful market research, and better sales and support. These trends, combined with an escalated emphasis on research and development, have created an increased demand for occupations such as technicians, technologists, engineers and sales people.

In the survey, companies were asked to estimate, for a wide range of occupation groups, the number of employees required over the next two years. Many of those responding did not enter estimates for each year, thus biasing the results downward. But the results indicate that the employment requirements for a number of occupation groups appear to be growing. Occupations using technical skills are expected to be the most in demand. These include research and development specialists, electronics technicians, communications and computer technologists, engineers and other product specialists who deal specifically with design, implementation and repair tasks in the industry. Specialized management skills, such as an engineering manager, are also seen as a growing area of need.

5.4.4 The Assemblers Debate

The topic of assemblers is of interest to many people in discussions dealing with technological change. Traditionally the view seems to be that new equipment technologies automatically imply losses of large numbers of assemblers. This is usually accompanied by the assumptions that assemblers are lesser-skilled, are easily replaceable, and are being replaced, in all aspects of the manufacturing process. The information provided below is a summary of some of the conclusions that can be drawn from various areas of the questionnaire concerning the assembler occupation that give evidence that this view and the underlying assumptions may not be valid.

There were two areas in the survey where assemblers could be classified. These classifications are determined by the amount of training necessary for the

requirements of the particular job or company. The majority of employees classified as assemblers were listed under the group that requires more than 6 months of training for the job - in other words, 'skilled'. Skilled assemblers captured a 25 percent share of total employment in 1986. The average number of employees in the skilled assembler occupation per respondent is about 200 for 1986. Both of these figures are significantly larger than for any other individual occupation.

Assemblers could also fall under a lesser-skilled group defined as jobs requiring less than 1 month of training. This was defined as a broad job family including occupations such as janitors, junior clerks and elemental labour, but indications are that the majority are unskilled assemblers. The entire 'unskilled' job family accounted for another 10 percent of total employment in 1986, with about 65 employees on average per respondent in 1986.

There are two points to be emphasized at this juncture. One is that with a combined share of employment of between 25 and 35 percent, the assembler occupation is an important one to this industry. The other key factor is that it is the 'skilled' assemblers, not the 'unskilled', that account for the lion's share of both the assembler occupation in particular and employment as a whole.

The share of skilled assemblers relative to total employment decreased from 32 percent in 1981 to 25 percent in 1986. This corresponds with a fall in the average number per respondent from 300 in 1981 to 195 in 1986. It is difficult to conclude what portion of this reduction is the result of technological change, if any, since the 1982 recession had a major impact on employment levels throughout the industry. There was further restructuring over the 1983 to 1985 period, with about 1,900 skilled assemblers reported as being permanently laved off by the survey sample.

On the other hand, though, there was a large number of assemblers recruited from local sources external to the firm, summing to 1,450 for 1983 through 1985. This was the highest relative to all other job families. A majority of the respondents reported having little difficulty finding qualified persons

within two weeks, but for 25 percent of the companies it took 2-5 weeks, perhaps indicating that assemblers are not as easy to find as some might initially think.

The near-term outlook for this occupation appears favourable. Few companies reported there were still surpluses that would need to be dealt with, and in terms of employment trends the share of skilled assemblers relative to total employment is expected to rise to about 27 percent for both 1987 and 1988. This is matched by an anticipated increase in the average per respondent to 210 for 1987 and 220 for 1988. In terms of averages, then, while some companies may be laying off, more are hiring.

These figures imply that the occupation of assemblers is neither stagnant nor obsolete, at least in terms of numbers. It is quite possible that the content of the job is changing with regard to the skills involved. There were a number of instances reported of assemblers receiving retraining to meet new skill requirements on both a formal and an informal basis.

5.4.5 Increases in Maintenance and After-Sales Service

Increased service and maintenance efforts are aimed at maintaining or improving market share. Some manufacturers are developing networks to service clients with competitors' products in the hope of capturing their business when replacements are needed. Internally, automated equipment is leading to the need for skilled troubleshooters to diagnose and correct problems as they occur. Breakdowns can cause delays which often have to be made up by expensive overtime and weekend work.

Less than half of the survey respondents reported employing persons specifically for after-sales service. After-sales service was defined in the survey as 'after-sales repair and maintenance provided for the products manufactured by the electrical/electronics industry'. A few indicated that their workers perform several duties, which may include after-sales service and repair. In response to changing products and greater emphasis on better

after-sales service, companies will require more after-sales support technicians. The proportion of after-sales service employees to total employment is expected to remain stable, or rise slightly. Sectors that foresee increases in this type of employment over the next five years include office and business equipment, small appliances and electrical industrial equipment.

5.4.6 Managers' Perceptions of Shortages in Labour Supply by Occupation

Table 5.4 illustrates the survey results of the anticipated inadequacy in qualified labour by occupation and by education for the period between 1986 and 1990. This information reflects the minimum-required education level for the various occupations.

Table 5.4

Shortages in Labour Supply
by Education and Occupation

University	College	High School
Computer engineer	CAD/CAM operator	Assembler
Communications engineer	Draftsperson	Coil winder
Electrical engineer	Robotics technician	Metal working machine operator
Project engineer	Power technician	Other sheet metal
Design engineer	Electronics technician	Computer operator
Electronics engineer	Computer operator	Machinist
Process engineer	Tool & die maker	Tool & die maker
Plastics engineer	Millwright	
CAD/CAM operator	Elec/electronic repair	
Robotics technician	Machinist	
Technical sales	Maintenance mechanic	
Other sales	Plant electrician	Other Training
Programmer	Welder	
R&D scientist	Machine set-up/operator	Welder
Computer operator	Plastic injection moulding	Machinist
Managers	Sales	
Systems analyst	Sheet metal worker	
	After-sales support	
	Instrumentation technologist	
	Service technician	
	Inspection technician	

It is chiefly the supply of engineering and technical expertise that is the concern of many companies. Many of the shortages are in occupations with a direct link to computers, such as programmers, systems analysts, and CAD/CAM operators. The title 'Computer Operator' shows up in all education categories except 'Other'.

5.5 Summary Findings and Conclusions

1) Technology is Changing the Skills People Need

There has been an evolution in generations of technology from electro-mechanical technologies to electronics. This evolution has created the need for different occupational and skill requirements. For example, the new technologies of production are changing the traditional demarcations between designers and tool makers as well as performing some of the machine set-up tasks. This has led to a perception among many workers that machines have led to 'down-skilling' of some of their traditional 'hands-on' work and replaced it with work which is more of a monitoring and controlling function. The technology is thus blurring the distinction between job classifications and leading to uncertainty on the part of many workers about their longer term job security.

While having to do less craftsmanship work, these line workers are being called upon to be more analytical. Because of the increased need to have short production runs with a minimum of product rework, they are being required to perform a wider variety of tasks and become more responsible for the quality of their own work. Thus the trend towards 'down-skilling' and 'multi-skilling' is coinciding with the need for employees to be more flexible, analytical and capable of solving problems as these arise. The operation of machines is increasingly requiring some basic literacy and the understanding of simple mathematics.

Most companies attempt to retain and retrain their existing employees when introducing new technologies. However, many workers are uncertain about the impacts of the technologies on the long term future of the organization. To combat this uncertainty, workers see improved employer and employee

communications and better training methods as the best ways of increasing productivity, cost efficiency and morale. Employee suggestions can bring dramatic product and process improvements, while more consistent contact with management lessens the shock of layoffs and cutbacks. Some companies who have older work forces have said that older workers have greater difficulty adjusting to change due to their seniority, tradition, and education level and may question whether it is really worth learning new technologies at their age.

New office technologies are also creating the need to have computer and keyboard literate office personnel. Poor implementation of these technologies can cause resistance and negate the productivity improvements they are intended to produce.

2) Demand for Certain Occupations is Changing

New technologies are changing job descriptions and blurring the traditional boundaries between jobs. In some situations, management's attempts to redefine the components and number of job descriptions have been resisted since they were perceived as strategies to reduce the compensation levels of line employees.

There may be a need for fewer unskilled, semi-skilled and administrative workers since these are the most exposed to displacement caused by the introduction of new technologies. There will be a greater need for skilled after-sales service and maintenance personnel to diagnose and solve problems as they occur.

Conclusions

The industry is not currently facing major shortages of workers in specialized trades and occupations as it once did in the past. Neither is there an overriding single issue or 'quick fix' which is needed to meet the human resources needs of the next decade. It was found, however, that a number of key issues now face the industry and government policy-makers:

- The industry needs to continually develop and monitor its skills and training needs in order to keep pace with technology, productivity and other forces which are driving the need for changing skills.

- New entrants into the work force must be equipped with all the basic skills required for companies to train them in as short a time as possible. New entrants include those leaving both the secondary and post-secondary educational levels.

- Skills upgrading and retraining requirements need the full support of government, employers, employees and their unions. Employers and unions need to actively encourage employees to develop and enhance their skills when necessary.

- Industry feels that government programs and funding to help the training needs of industry should increasingly focus on skills upgrading. Individual companies and their unions are the ones to identify specific training and the upgrading of skills required and, as such, any government funding or assistance of training programs should be controlled by the recipient company.

- Many mature workers in the industry face the need for retraining. In many situations, this may involve the need for longer-term as well as short-term training in order for such workers to acquire the basic educational skills necessary to cope with a changing work environment. The industry needs to discuss with unions, government and educational institutions how best to address the upgrading and retraining needs of older workers.

- The industry needs to encourage more interaction between academic staff from community colleges, universities and companies with the appropriate representatives from the electrical and electronics industry. Academics need regular interaction with the industry in order to stay current with the changing needs of the industry.

- The industry should consider ways and means of encouraging and directing companies who face the need to upgrade or redirect the skills of their work force. A data base of specific training already conducted by member companies could, for example, help those firms who have identified a need for training to quickly find colleges, companies and individuals who could conduct the training or provide assistance. In Ontario, such a data base could fit within the objectives of the new Institute for Skills Training of the Ministry of Skills Development.

6. ADJUSTMENT PATTERNS IN THE SECTOR

The examination of the electrical and electronics manufacturing industry has shown that it is facing increasing international competition and rapidly changing markets. In responding to these pressures, the industry is restructuring. In the past, this restructuring has lead to labour displacement and, in the current dynamic environment, further displacement will occur. As Section 3.3.3 illustrated, even when total employment increased, the industry was characterized by numerous plant expansions, start-ups, contractions and closings.

In such a rapidly changing environment, efficient labour market adjustment takes on added importance if satisfactory economic growth and reduced unemployment is to be achieved. From a government policy perspective, not only must the transition of labour from one activity to another be as efficient as possible, but the cost of this transition must not be unduly borne by one group of individuals.

Although the labour market over the next few years is likely to be different than that of the past decade, an examination of past employee adjustment patterns provides a better understanding of the process, and highlights potential avenues for future policy.

Whether the loss of jobs is due to international pressures, changing demand, a more competitive environment or technological change, it inflicts hardship on individuals, groups and communities.

6.1 What Happens to Individuals When Laid Off

The following gives an overview of some of the experiences of companies and employees faced with a plant shutdown or layoff.

The decision which each individual makes is motivated by a complex number of considerations including:

- expected duration or severity of company down time;
- expected security of long-term employment with the company;
- age and tenure or seniority of employee;
- availability of alternative acceptable employment prospects in the area;
- primary or secondary income earner;
- willingness to relocate (for both the individual and family);
- willingness to upgrade skills.

Based on these considerations, an individual may decide to adopt one or several of the following:

- Collecting unemployment insurance. The majority of workers displaced by technological or industrial changes spend considerable time unemployed before either being recalled or finding alternative employment. Problems can become acute outside of large urban centres where there is often a lack of alternative employment opportunities. It has been suggested that collective agreements which supplement UIC payments during layoffs could also act to demotivate individuals from seeking alternative employment immediately.

- Waiting to be recalled when the company begins production once again. Individuals in the focus groups explained that it did not make sense for them to take on a job with another company as it would mean less pay than what they would receive from UIC. It would also lead to forfeiting the opportunity to obtain employment with the company once production recommenced. It would appear that, as many of the production employees in the industry are secondary income earners, there may be some ability for the family unit to wait out these periods more so than would be the case with a primary income earner.

- Personal upgrading of skills on own initiative. It does not appear to be common for unemployed workers to upgrade or retrain themselves during such periods, however, some individuals do take advantage of these periods to upgrade themselves. Workers, particularly the younger ones, who have some advanced education or skills, tend to see it as their own responsibility to remain current on technological developments. This may be because of greater appreciation of higher technology or because of competitive job pressures.

- Seeking employment with another employer. Employees are most likely to seek employment with another employer if it is available in the immediate area. This is most likely to be the situation in the larger urban centres.

- Moving to another part of Canada. Some individuals move to other parts of Canada as the result of a plant shutdown in the hopes of obtaining employment in other regions. The decision to move is considerably easier for those persons who are either single or who maintain contacts in other centres.

6.2 The Companies' Experiences When Faced With Layoffs

A company in a layoff situation is likely to lose some portion of its labour force due to individuals finding employment with other companies in the community or in other areas. Employees in the study's focus groups were usually aware of friends who had left the area during a layoff and others who had found employment with other employers either in the same sector or in other sectors.

Some individuals suggest that employers should provide retraining during down-time more often than is now company practice. Companies appear to respond to fluctuations in markets in a number of different ways. These are unique to the individual companies and are not necessarily shared by other companies within the same sectors. Some companies seem to be making an extra effort to maintain and retrain their existing work forces in response to poor economic conditions, rather than laying off. This emphasis is motivated in part because it is felt that there is considerable cost in training a new work force. It is often felt that even the most unskilled jobs have a learning element to them and that it takes time to develop productivity in new workers.

6.2.1 The 'Temporary Work Force'

Some companies have laid off and then recalled workers on more than one occasion to the extent that they refer to having access to a 'temporary work force' which they can rely on.

Other companies go out of their way not to lay off workers. Some companies, for example, attempt to keep their labour forces always slightly below industry norms; a prospective employee's willingness to put in overtime is a strong prerequisite for employment with these companies. During the recession, one company bid on contracts which it would not normally undertake in order to keep its workers.

Some companies also require that their employees undertake an extensive training course prior to beginning their employment. Clearly, the laying off of

workers would represent a considerable cost to these companies if they were to have to retrain large numbers of workers after each rehiring.

6.2.2 Work Sharing

A number of companies interviewed in western Canada had established work-sharing programs during the recession. In some instances, this approach was combined with salary cutbacks. Through these work-sharing programs, companies were able to avoid or minimize layoffs. Companies which adopted work-sharing programs saw this solution as a way of retraining valued employees. To replace these experienced employees would require a considerable amount of training and effort. This motivation is as important as other factors such as the desire of companies to be equitable with their employees or the social appeal of not having to lay off employees. It is possible that the difficulty expressed about replacing skilled employees is less of a concern in a large labour market such as southern Ontario.

6.2.3 Retraining During the Layoff

Once the decision to shut down production has been made, companies may provide some retraining during this period; however, this would appear to be done in only a small number of cases. In the workshops with employees, a number of employees felt that companies should provide more upgrading during these periods. A few companies are using slack or retooling periods to keep their work force up-to-date. However, down-time is not always planned, so there is a demand for 'off-the-shelf' training programs that can be used at any time and with little preparation.

6.2.4 Supplementing Unemployment Insurance Benefits

A few large firms in the industry, as part of their collective agreement with unions, supplement unemployment insurance benefits to those laid off. These payments can bring an unemployed person's income up to as much as 90 percent

of previous earnings and can last for up to a year, depending upon seniority. These measures not only provide help for older workers who may have a more difficult time finding new jobs, but they reduce a firm's incentive to use layoffs as a manner of reducing costs, since substantial payments must be made to the unemployed. It is possible that such supplements create a disincentive for a person to look for new work, particularly in areas where alternative high-paying jobs are scarce.

6.2.5 Early Retirement Incentives

This program is used in order to increase flexibility in the work force and to reduce 'top-heaviness' in the organization. Cash payments or the topping-up of pension benefits induce many to voluntarily retire early, thereby freeing positions for less-senior workers. A number of companies in the industry offer early retirement incentives at the same time that they are recruiting new graduates from colleges and universities. Use of these incentives also helps companies make organizational and job classification changes.

6.3 Managing the Work Force to Handle Temporary Increases in Production

It is rarely a practice of the industry to adopt any unusual approaches to work force management to accommodate temporary increases in production. Usually the full-time work force is paid overtime to perform this additional work.

6.3.1 Permanent Part-time Employment

Permanent part-time employment (i.e., less than 30 hours per week) has not been a traditional feature of this industry although some companies feel that this approach may be used more in the future to accommodate the dual problems of temporary increases in production and unemployment in the local community.

6.3.2 Contract Employment

Some companies, especially in the aerospace sector, use contract employment. Individual contracts which the company bids on may involve several person-years of employment tied very specifically to individual projects which themselves may go on for several years. When these projects are completed the companies usually hope to phase these individuals into other projects which have been developed during the interim.

6.3.3 Casual Employment

One company has introduced a concept which it refers to as 'casual' workers which it employs to replace employees who are absent because of vacation, sickness, or leave of absence. These workers may also be employed if there is a temporary increase in production and may be hired for permanent employment if there are openings. The casual workers receive a 5 percent premium on the wage of the position being filled because of the lack of employee benefits.

6.4 CEIC Research into Employee Adjustment Patterns

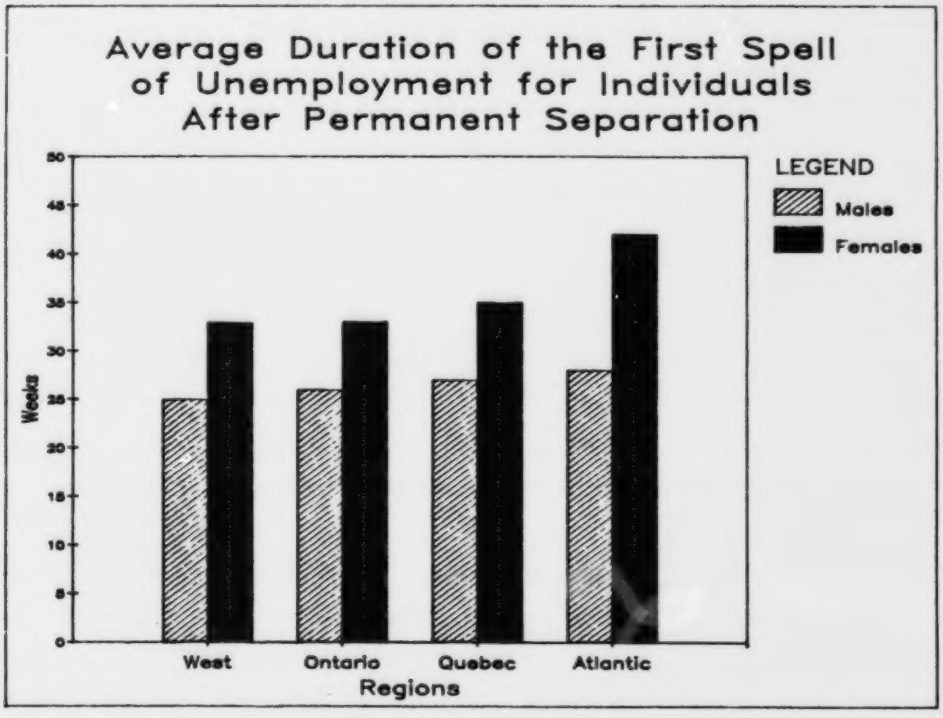
This section addresses the post-separation adjustment experiences of workers in the electrical and electronics industry based on research conducted by CEIC. CEIC analyzed the experiences of a 10-percent sample of workers who, between January 1978 and January 1983, had at least one spell of employment in the electrical and electronics manufacturing sector and then left the industry. This study reviewed: the average time unemployed after separation from the industry and before obtaining a job elsewhere; the industry in which workers found their next job; and the degree of income loss or gain in their new employment. Each of these is addressed in the following sections.

6.4.1 Unemployment Experiences of Separated Workers

Although the vast majority of workers who separated from the electrical and electronics industry were absorbed by other sectors, there were costs of dislocation. These costs largely depended upon the duration of unemployment experienced by the workers prior to finding a new job. In turn the duration of unemployment depends upon an individual's skills, age, sources of alternative income and the economic conditions in a region at the time of separation.

Figure 6.1 illustrates the average duration of the first spell of unemployment after an individual's permanent separation from the electrical and electronics industry. The average duration varies by region and by sex. For males, the average duration of unemployment varied from a low of 25 weeks in the western provinces to a high of 28 weeks in the Atlantic provinces. Female

Figure 6.1



workers in Ontario and the west were unemployed for an average of 33 weeks, while the duration was 42 weeks in the Atlantic provinces. The average 29-week

duration in Ontario for both sexes is comparable to that found in other industries. Studies have shown that the average duration of unemployment for workers who were permanently separated from the automotive industry over the same time period was 27 weeks, and for separated metal mining workers it was 28 weeks.

Table 6.1 shows the distribution in weeks unemployed for all individuals, by age groups, separated from the industry in Ontario, where 16 percent of the individuals were unemployed for a year or more after separation. Similar distributions for other regions are shown in Appendix V.

Table 6.1

Distribution of the Duration of the First Spell of Unemployment After Permanent Separation from the Electrical/Electronics Sector by Age Group

ONTARIO

Duration of Unemployment (weeks)	All Individuals (percent)	Age Group 20	20-29	30-39	40-49	50+
			(percent)			
5	16	12	17	18	13	16
5-12	18	18	17	15	22	23
13-25	23	26	22	22	23	17
26-50	27	28	28	26	32	22
51+	16	16	16	19	10	21

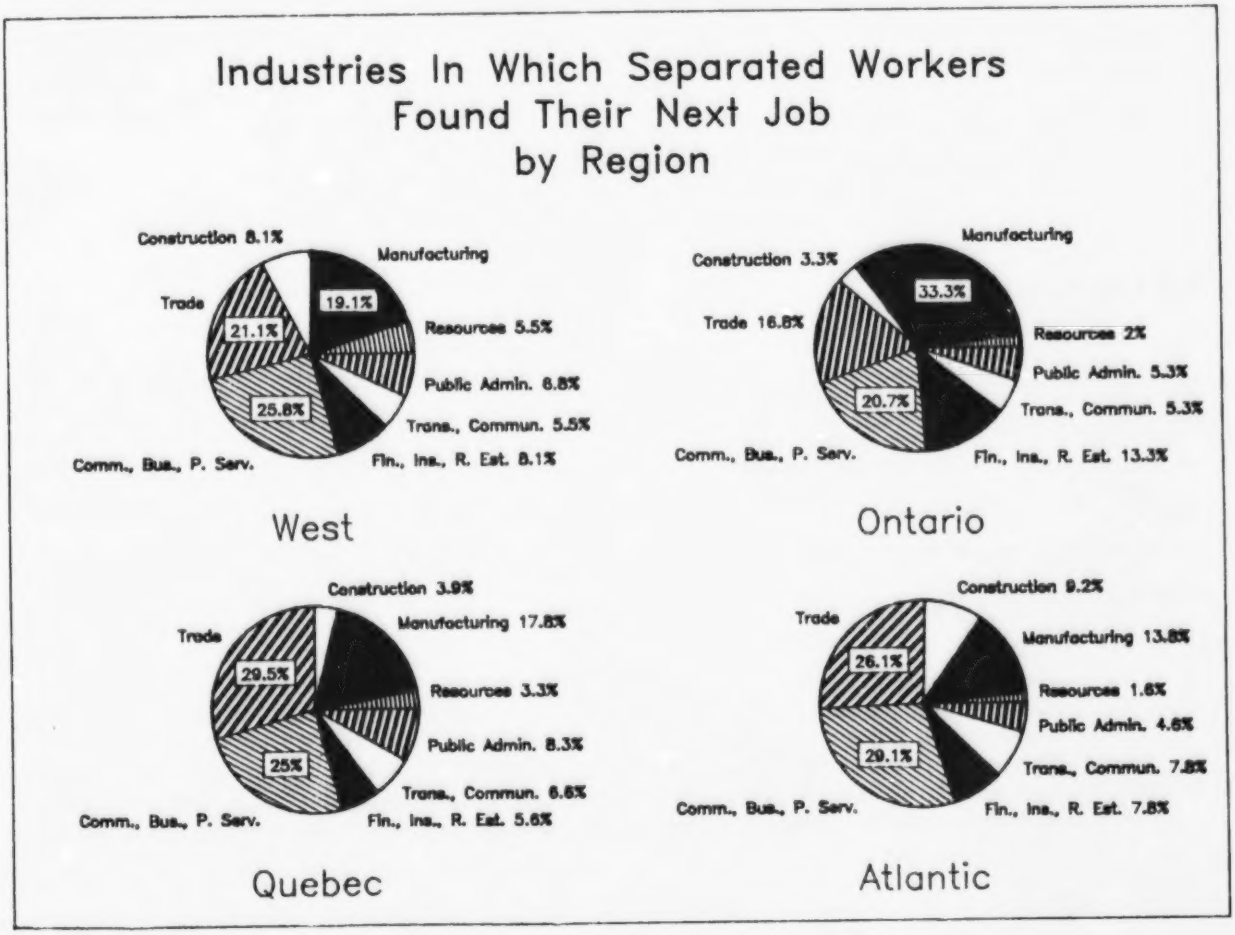
Workers in the Atlantic provinces were worse off in this regard, with 23 percent experiencing unemployment durations of a year or more. The over-50 age group was also worse off in that 21 percent of this group in Ontario had unemployment durations of a year or more. On the other hand, only 12 percent of the under-20 group managed to obtain employment within 4 weeks.

In summary, the average duration of unemployment after permanent separation from the electrical and electronics manufacturing sector is approximately seven months, not unlike the unemployment durations for workers who separated from other industries. For some workers, the job loss results in a brief spell of unemployment and the cost in terms of time unemployed is slight. However a large number of workers face protracted unemployment and the re-adjustment to the job loss is more severe.

6.4.2 The Next Job

It is important to note that a very high proportion of workers 'flow through' an industry's work force. For example, of the 131,000 employed in the electrical and electronics industry in January 1978, only 48 percent were still employed in the industry by January 1983. Fifty-two percent of those employed in January 1978 had left the industry, either through layoffs, quits, retirements, etc., and had been replaced by other workers. This estimate compares with 62 percent retention in the automotive industry and 39 percent in the metal mining industry over the same period.

Figure 6.2



From a labour adjustment perspective it is of interest to identify the industries which absorbed workers who separated from the electrical and electronics manufacturing industry. This inter-industry mobility, the movement of workers from one industry to another, provides some measure of response of workers to differential employment opportunities. Figure 6.2 illustrates the distribution of industries in which separated workers found their next job. Only a small proportion of workers found their next job in the manufacturing sector. The vast majority were absorbed into the much-faster growing service sector.

6.4.3 Change in Earnings for the Separated Worker

Even when a separated worker finds a job, a loss in wages often results, at least initially, compared to his or her previous job. In the case of our sample, however, the change was not found to be large. Workers in Quebec and Ontario initially lost an average of 4.6 percent and 1.4 percent of their earnings respectively. Conversely, workers in the Atlantic provinces and the west experienced average earnings increases of 6 percent.

6.5 Conclusions

There will not be easy solutions to the problem of layoffs and the labour adjustment process. Clearly, the nature of the problem is likely to be different depending on the expected duration of the layoff, the location of the layoff, the age of the individuals affected, the prospects of finding alternative suitable employment, or whether the individuals are the primary or secondary household wage earners.

- The industry, government and the unions must develop a variety of approaches to address the problem of layoffs and the need to retrain workers. These approaches must address the issues of physical and financial access to training and access to jobs either in the same industry sector, alternative industry sectors or in communities. Pension reform, which encourages labour mobility, is a positive step in this process.

- The industry and government will increasingly have to address the problems created by labour adjustments and layoffs. Those displaced by the industry will have to be retrained for jobs in the industry or in other manufacturing or service sectors. This could be a major problem since the electrical and electronics industry is one of the most successful in Canadian manufacturing and other manufacturing sectors may face even worse prospects for job creation and retention of employees.

- Although government should retain traditional support for unemployed workers, the industry feels that government policy should increasingly be aimed at encouraging employed workers to stay up-to-date and upgrade their skills.

To be successful, these directions need the full commitment and support of all those involved - employers, employees and their representatives, and government at both the federal and provincial levels. There is a clear need for good communication between these groups in order to alleviate the many fears that can arise due to change.

7. HUMAN RESOURCE CONSIDERATIONS

7.1 Companies Reviewing the Role of Human Resources Internally

A number of companies, until recently, had no formal human resource department. However, changing market conditions, rapidly changing human resource requirements, skills training requirements, and the need to manage new forms of work organization are forcing the movement of human resources from an administrative function to a strategic one. As such, the senior individuals responsible for human resources management are increasingly being included on the firm's senior executive committee.

Companies view their approach to human resources quite differently even within the same sector. In some companies human resources are referred to and viewed as 'industrial relations' or 'employee relations'. Individuals responsible for these departments may focus much of their attention on these aspects of the human resources function as opposed to others such as training. To some extent this is most understandable given the recent volatility in the industry.

Some companies reduced their human resources departments, as well as others, during the recession and may continue to operate with a relatively small number of personnel in these departments.

7.2 The Training Imperative

The need to provide skills training is an imperative given the changing technological environment affecting the industry. This applies to all employees in the organization. The industry will probably never again experience the relatively stable period of the 1960s and 1970s. While there have always been fluctuations in production, companies feel that the disruption of the early 1980s was unlike other periods experienced by the industry. The competitive forces which led to the instability in the industry are not about to subside.

There will be increasing pressure on companies to adopt more technologies and to upgrade employees to operate these technologies effectively. Continued job displacement by these technologies will no doubt be a part of the industry as it is in other industry sectors. There is little alternative however. To ensure continued vitality and viability, the industry must proceed with adoption of new technology and provide appropriate training. The traditional training and educational institutions will continue to play their role; however, in many ways the environment is changing too quickly for these institutions to respond directly to industry needs. The solution must come from industry. More short term, on-the-job training is the only approach which will effectively prepare today's employees for the technologies which are in use today and will continue to emerge and evolve. Training from this perspective must be seen as an investment in survival rather than a cost of doing business.

7.3 Use of Government Assistance Programs

Larger companies, especially those with senior managers responsible for human resources are those who are the most knowledgeable and experienced in dealing with government on training-related issues.

The emphasis of most employers is on the short-term training needed by employees. Many companies in Ontario are very supportive of that province's Training in Business and Industry (TIBI) program.

In some mature industries such as manufacturers of small appliances, the opinion was expressed that government must refocus its attention to the maintenance of existing jobs rather on the creation of jobs.

A variety of opinions were expressed about government programs. Some felt that there was too much red tape to make the exercise worthwhile. Others felt that tax advantages ultimately have more of an impact on the decisions which companies take. Some smaller companies indicated they use 'any program they can get' because it has a direct impact on their bottom line.

Some employers perceive that technical programs in colleges are having their lowest level of recruitment in a number of years and see the increased number of students entering arts and social science courses as a more fundamental problem that industry must cope with. They are concerned about potential skill shortages. However, data concerning electrical engineering and technical graduates indicate that their numbers have risen steadily since 1977. Refer to Appendix IV for details.

7.4 Problems of Recruitment and Job Retention

In most situations, employers do not have difficulty finding individuals to fill job openings. In some companies using the older technologies, problems may arise when the level of technology on the shop floor is below the skill capabilities of recent college graduates since these individuals feel they are over-trained for these jobs.

Employers often claim that new graduates and other younger entrants no longer arrive with an expectation that employment with that particular company will be for life - or that promotion will be automatic based on years of service and seniority.

Some employers have taken steps to address this issue by introducing programs designed to enrich jobs and help their employees cope with 'flatter hierarchies' since many will not have the traditional rewards of promotion available to them. Typically many of these programs address 'softer' productivity issues such as good communications, decentralization of decision making, and group problem solving.

Many employers reported that they were pleased with the University of Waterloo's Co-op programs which are used as a low-cost method of screening employees who will be entering skilled positions.

7.5 Some Special Strategies May be Adopted in the Future

The industry traditionally has not been a large user of part-time and temporary employment in the production process. It is seen by some manufacturers as an expensive method of human resource management. Temporaries and part-timers are perceived to require considerable training resources and show less loyalty to the firm and at times, as a result, are seen to have a detrimental effect on product quality. It is a more common practice for employers to lay off and recall workers as they are needed. Contract work is mostly confined to specialists who may be recruited for special projects.

Job security is becoming an issue for some companies which have an aging work force. Many employees are not ready for forced retirement in their forties and fifties. Some companies reported that older workers are less able to accept new working concepts than younger workers, thus increasing their vulnerability to technological change. Special strategies may have to be developed in the future to assist in training or easing these individuals into retirement. The adoption of employment methods such as job sharing, part-time and contract employment may be brought about by social demands.

7.6 The Need for Human Resources Planning

A formal system of human resources planning usually has three components. First, 'Projection of Staffing Requirements' including projections of sales, equipment and process changes, and turnover rates. Second, 'Monitoring of Availability of Workers' including the monitoring of in-house inventories, training-in-progress and the availability of qualified new hires. Third, 'Matching of Requirements and Availability' including training plans, layoff policy and researching of other sources for qualified new hires where potential shortfalls have been identified.

Based on this definition, only 34 percent of survey respondents have a formal human resource planning process. A number of companies have more informal methods of human resource planning which can include elements of the

above process. When asked why they do not have a formal planning process, many companies responded that they have no difficulty finding workers or that they have difficulty forecasting requirements or availability. Other reasons given were: there is no need; no money; no time; it is a waste of money; and the company is too new or too small.

Clearly, given the expected continued volatility of the markets, continued technological change and uncertainty, companies will have to conduct human resources planning in its broadest sense. This includes not just quantitative projections, but the full array of human relations policies such as recruitment, training, work force management and organization, and human relations. Other issues to be considered include some of the 'softer' productivity issues caused by flatter hierarchies throughout the organization, including creative approaches to problem solving, encouragement of entrepreneurialism within companies and the need to communicate at all levels.

7.7 Summary Findings and Conclusions

1) Human Resource Management is Becoming Increasingly Important

Spurred by the rapid developments over the past five years, human resources planning is only now becoming a common practice in the industry. While personnel departments existed before, many firms have upgraded their status by bringing in more skilled human resource professionals. Human resources is evolving from an administrative function to a management function. The volatile business environment, while making planning more difficult, has increased the need to plan. Gaining familiarity with possible future business developments ensures smoother production and labour adjustments then simply a 'wait and see' planning attitude. The industry needs to become more proactive, rather than reactive.

2) Educational institutions and industry must respond to the new training challenge

The longer term need for new entrants to the industry is a concern to employers. Many firms are satisfied with the quality and skills of people

emerging from community colleges and universities. However, because of the increasing emphasis on multi-skilling and the need for more analytical and communication skills, some companies want people with better general literacy and numeric skills.

Given that many companies are increasingly emphasizing the role of research and development, some companies felt that there should be a much stronger symbiotic relationship between industry and the research capabilities of the universities. Educational institutions are not seen as being at the leading edge of technological development.

Increased and better training is seen by companies as an integral part of their long-term success, but this attitude is by no means universal. Short term on-the-job training is the main way in which companies see their immediate needs being met with their existing work force. Most employees also appear willing to learn the new technologies. Employees take an active interest in the success of their company and are willing to help where possible. However, the recent past has left many with feelings of uncertainty about their own futures.

The need to provide appropriate skills training is imperative given the changing technological environment affecting the industry. This applies to all employees in the organization. The industry will probably never again experience the relatively stable period of the 1960s and 1970s. While there have always been fluctuations in production, companies feel that the disruption of the early 1980s was unlike other periods experienced by the industry. The competitive forces which led to the instability in the industry are not about to subside.

Possible job displacement by these technologies will no doubt be a part of this industry as it is in other industrial sectors. However, there is little alternative. To ensure continued vitality and viability, the industry must continue to adopt new technologies and provide appropriate training. Training and the adoption of these technologies from this perspective must be seen as an investment in survival rather than a cost of doing business.

Conclusions

On the key issue of upgrading and training the industry's work force, it was found that many companies, particularly the larger ones, have already introduced and trained many of their employees in response to the adoption of new technology. Almost all companies regard the training challenges they face as being one which only they can define and implement. The following directions are ones which the industry supports in order to better address the issue of retraining and skills upgrading.

- Despite the increasing difficulty of conventional long-term forecasting in the industry, there is a need for the industry to plan its long-term strategy for survival. Human resources are part of the investment necessary for long-term survival.

- The industry should work with community colleges, universities and government to help them implement a wide variety of on-the-job cooperative training programs. These may include traditional apprenticeship-style training or cooperative education programs which involve alternating periods of employer-sponsored on-the-job training and training in educational institutions. In turn, the industry and unions must be prepared to support these programs.

APPENDIX I

SURVEY METHODOLOGY

The Research and Special Studies Division of the Canadian Occupational Projection System (COPS), with the cooperation of the Electrical and Electronic Manufacturers Association of Canada (EEMAC) conducted a survey of the manufacturers in the sector. The survey content consisted of the following major sections:

Content

- Company Profile
  - products produced
  - volume of sales
  - employees
  - work force characteristics
- Technological Trends
  - technologies currently in use
  - changes anticipated to 1990
- Work Force Implications
  - recruiting implications
  - skills, education and training implications
  - human resource planning implications

Methodology

COPS prepared a master list of electrical and electronic products manufacturers, including the list of EEMAC members. The design of the questionnaire was led by COPS and included the full expertise of the study's steering committee. The survey was mailed out in March 1986 and the responses were tabulated the following July.

Survey Response and Sample Representativeness

Completed questionnaires were received by 114 companies. Employment by the respondents totalled 51,777 or about 35 percent of the industry. Table I.1 below compares the distribution of employment across the 3-digit Standard Industrial Classification (SIC) industry groups as defined by Statistics Canada.

Table I.1

Distribution of Employment by S.I.C. Group

	Total Industry[1]	Survey[2]
	(percent of total)	
Office, store and business machines	11.6	13.6
Small appliances	3.7	3.4
Major appliances	6.7	2.0
Lighting fixtures	6.3	1.3
Radio and television receivers	1.8	3.2
Communications equipment	35.1	41.4
Electrical industrial equipment	15.3	14.5
Electric wire and cable	5.7	5.0
Miscellaneous electrical products	5.9	6.2
Scientific instruments	7.9	9.4

[1]Source: Statistics Canada, 1984 Census of Manufacturers
[2]Source: 1986 EIC survey

The survey sample distribution of employment corresponds closely to that of the total industry. Table I.2 shows the regional distribution in percent terms of both the number of firms and employment, for the survey respondents and the industry as a whole.

Table I.2

Establishment and Employment Distribution by Region
(Percent)

	Number of Firms		Employment	
	Actual[1]	Survey[2]	Actual[1]	Survey[2]
Quebec	22.5	15.8	19.6	8.8
Ontario	58.4	68.4	77.4	88.4
Rest of Canada	19.1	15.8	3.0	2.8

[1]Source: Statistics Canada, 1984 Census of Manufacturers
[2]Source: 1986 EIC Survey

Ontario appears to be over-represented in the sample, due primarily to the location definition used in the questionnaire. The number of firms and the level of employment were assigned to the origin of the respondent. Distortions arose when head offices, typically located in Ontario, reported aggregate results for a number of plants distributed across the country.

Table I.3 below shows the distribution of the number of establishments by size of company according to the number of employees. Small companies have been defined as those employing fewer than 100 people. Medium-size companies are defined as employing 100-500 people and large companies employ more than 500. The EIC survey sample substantially under-represents smaller firms while it over-represents medium and large firms.

Table I.3

Establishment Size Distribution by Employment

	Actual[1]	Survey[2]
	(Percent)	
Small	80.3	49.1
Medium	16.5	33.3
Large	3.2	17.5

[1]Source: Statistics Canada, 1984 Census of Manufacturers
[2]Source: 1986 EIC survey

Plants engaged in the manufacture of mature assembly-line types of products, such as major appliances and radios and televisions, tend to be the largest. On average they employ 200-300 persons per plant, 2-3 times the industry norm of just over 100. The highly labour-intensive electric lighting fixtures industry has the smallest plants, averaging just under 50 employees per establishment.

APPENDIX II

INDUSTRY ECONOMIC DATA 1978-84

As of 1982, Statistics Canada reclassified all manufacturing data according to an updated 1980 definition of the Standard Industrial Classification (SIC) system. Because of the rapid technological change within the electrical and electronic sector, the reclassification had a slight impact on the number and type of firms within each SIC category. The data presented in the following tables reflect the closest-possible matching of the 1970 and 1980 SIC definitions. Figures for 1982 are presented for both SIC definitions, and while the levels may not match in some cases, percentage change calculations can provide a reasonable profile of changing industry conditions over the 1981 to 1983 period.

Table II.1

Matched 1970 and 1980 SIC Definitions for the Electrical and Electronics Manufacturing Industry

1970 SIC	Sector	1980 SIC
268	Lamps and shades	333
318	Office, store & business machines	336
331	Small electrical appliances	331
332	Major appliances	332
333	Lighting fixtures	333
334	Record players, radio & television receivers	334
335	Communications equipment	335
336	Electrical industrial equipment	337
338	Electric wire & cable	338
339	Miscellaneous electrical products	339
3911	Indicating, recording & controlling instruments	3911

ELECTRICAL AND ELECTRONICS MANUFACTURING INDUSTRY SECTORS
Principal Statistics

Office & Store Machinery		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 318)				(1980 SIC 336)		
Establishments	number	55	64	75	71	92	92	106	135
Employment	number	9,629	11,791	13,540	16,161	16,930	16,856	15,883	17,155
	%ch		22.5	14.8	19.4	4.8		-5.8	8.0
Shipments	$m	738.2	1,034	1,228.0	1,565.2	1,727.7	1,725.4	1,786.2	2,259.3
	%ch		40.1	18.7	27.5	10.4		3.5	26.5
(price data not available)									

Major Appliances		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 332)				(1980 SIC 332)		
Establishments	number	35	52	59	67	34	na	26	34
Employment	number	12,806	13,884	13,824	12,843	9,872	10,271	10,719	9,880
	%ch		8.4	-0.4	-7.1	-23.1		4.4	-7.8
Shipments	$m	799.9	908.2	976.5	987.0	818.1	850.7	988.9	991.5
	%ch		13.5	7.5	1.1	-17.1		16.2	0.3
Industry Selling Price Index	1981=100	76.7	81.1	89.0	100.0	110.5	110.5	117.6	121.3
	%ch		5.8	9.7	12.3	10.5		6.5	3.1
Real Shipments	1981$m	1,042.8	1,119.3	1,096.8	987.0	740.5	770.0	840.6	817.4
	%ch		7.3	-2.0	-10.0	-25.0		9.2	-2.8
Real Shipments per Employee	1981$000's	81.4	80.6	79.3	76.9	75.0	75.0	78.4	82.7
	%ch		-1.0	-1.6	-3.1	-2.4		4.6	5.5

Small Electrical Appliances		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 331)				(1980 SIC 331)		
Establishments	number	64	66	62	63	64	na	62	58
Employment	number	5,181	5,161	5,167	5,368	5,147	5,137	4,939	5,513
	%ch		-0.4	0.1	3.9	-4.1		-3.9	11.6
Shipments	$m	425.3	458.3	474.6	523.4	545.2	543.8	591.8	694.6
	%ch		7.8	3.6	10.3	4.2		8.8	17.4
Industry Selling Price Index	1981=100	83.4	86.1	91.9	100.0	109.3	109.3	112.3	115.0
	%ch		3.3	6.7	8.8	9.3		2.8	2.4
Real Shipments	1981$m	509.9	532.0	516.2	523.4	499.0	497.7	527.0	604.1
	%ch		4.3	-3.0	1.4	-4.7		5.9	14.6
Real Shipments per Employee	1981$000's	98.4	103.1	99.9	97.5	97.0	96.9	106.7	109.6
	%ch		4.7	-3.1	-2.4	-0.6		10.1	2.7

Lighting Fixtures		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 268,333)				(1980 SIC 333)		
Establishments	number	147	162	165	166	168	na	174	186
Employment	number	5,589	5,223	5,385	5,259	4,786	8,139	8,437	9,229
	%ch		-6.5	3.1	-2.3	-9.0		4.1	8.9
Shipments	$m	255.9	304.2	342.6	384.0	339.8	756.9	808.1	976.9
	%ch		18.9	12.6	12.1	-11.5		6.8	20.9
Industry Selling Price Index	1981=100	64.9	78.7	87.0	100.0	108.4	108.4	117.1	122.1
	%ch		21.3	10.6	14.9	8.4		8.0	4.3
Real Shipments	1981$m	394.4	386.4	393.6	384.0	313.4	698.1	690.3	800.2
	%ch		-2.0	1.9	-2.4	-18.4		-1.1	15.9
Real Shipments per Employee	1981$000's	70.6	74.0	73.1	73.0	65.5	85.8	81.5	86.7
	%ch		4.8	-1.2	-0.1	-10.3		-5.0	6.4

Radio and Television Receivers		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 334)				(1980 SIC 334)		
Establishments	number	18	22	19	15	16	16	16	16
Employment	number	2,332	2,946	2,889	3,327	2,857	2,906	2,749	2,676
	%ch		26.3	-1.9	15.2	-14.1		-5.4	-2.7
Shipments	$m	284.8	352.1	406.2	505.9	499.6	502.8	542.6	592.0
	%ch		23.6	15.4	24.5	-1.2		7.9	9.1
Industry Selling Price Index	1981=100	90.0	93.1	95.2	100.0	100.1	100.1	98.9	92.8
	%ch		3.4	2.3	5.1	0.1		-1.2	-6.2
Real Shipments	1981$m	316.3	378.3	426.8	505.9	499.2	502.4	548.6	638.2
	%ch		19.6	12.8	18.5	-1.3		9.2	16.3
Real Shipments per Employee	1981$000's	135.6	128.4	147.7	152.1	174.7	172.9	199.6	238.5
	%ch		-5.3	15.0	2.9	14.9		15.4	19.5

Communications Equipment		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 335)				(1980 SIC 335)		
Establishments	number	331	384	411	427	443	na	423	476
Employment	number	37,895	39,326	43,343	46,330	45,629	45,790	45,087	51,769
	%ch		3.8	10.2	6.9	-1.5		-1.5	14.8
Shipments	$m	1,777.3	2,167.8	2,722.7	3,191.0	3,520.1	3,529.0	3,625.9	4,301.8
	%ch		22.0	25.6	17.2	10.3		2.7	18.6
Industry Selling Price Index	1981=100	90.3	92.6	95.1	100.0	103.5	103.5	106.2	110.2
	%ch		2.5	2.8	5.1	3.5		2.6	3.8
Real Shipments	1981$m	1,968.6	2,342.1	2,862.6	3,191.0	3,401.1	3,409.7	3,415.4	3,903.0
	%ch		19.0	22.2	11.5	6.6		0.2	14.3
Real Shipments per Employee	1981$000's	51.9	59.6	66.0	68.9	74.5	74.5	75.8	75.4
	%ch		14.8	10.9	4.3	8.2		1.7	-0.5

Electrical Industrial Equipment		1978	1979 (1970 SIC 336)	1980	1981	1982	1982 (1980 SIC 337)	1983	1984
Establishments	number	243	251	253	264	264	255	256	264
Employment	number	27,150	28,733	28,530	30,060	27,486	27,523	23,147	22,576
	%ch		5.8	-0.7	5.4	-8.6		-15.9	-2.5
Shipments	$m	1,358.7	1,735.5	1,878.9	2,220.1	2,203.5	2,205.6	1,792.7	1,918.0
	%ch		27.7	8.3	18.2	-0.9		-18.7	7.0
Industry Selling Price Index	1981=100	70.7	78.6	91.3	100.0	110.2	110.2	112.9	118.2
	%ch		11.2	16.1	9.6	10.2		2.5	4.7
Real Shipments	1981$m	1,922.1	2,208.6	2,059.1	2,220.1	1,996.5	2,001.2	1,587.4	1,622.2
	%ch		14.9	-6.8	7.8	-10.1		-20.7	2.2
Real Shipments per Employee	1981$000's	70.8	76.9	72.2	73.9	72.6	72.7	68.6	71.9
	%ch		8.6	-6.1	2.3	-1.6		-5.7	4.8

Electric Wire & Cable		1978	1979 (1970 SIC 338)	1980	1981	1982	1982 (1980 SIC 338)	1983	1984
Establishments	number	42	45	48	52	52	na	55	58
Employment	number	9,036	9,383	8,691	9,157	8,567	8,567	8,101	8,480
	%ch		3.8	-7.4	5.4	-6.4		-5.4	4.7
Shipments	$m	804.3	1,088.8	1,202.4	1,333.0	1,148.0	1,119.0	1,061.1	1,256.5
	%ch		35.4	10.4	10.9	-13.9		-5.2	18.4
Industry Selling Price Index	1981=100	65.2	82.2	97.9	100.0	104.7	104.7	107.5	111.1
	%ch		26.0	19.1	2.1	4.7		2.6	3.3
Real Shipments	1981$m	1,233.5	1,324.8	1,228.0	1,333.0	1,096.3	1,068.6	987.4	1,131.4
	%ch		7.4	-7.3	8.5	-17.8		-7.6	14.6
Real Shipments per Employee	1981$000's	136.5	141.2	141.3	145.6	128.0	124.7	121.9	133.4
	%ch		3.4	0.1	3.0	-12.1		-2.3	9.5

Miscellaneous Electrical Products		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 339)				(1980 SIC 339)		
Establishments	number	148	158	146	143	149	na	117	118
Employment	number	15,951	16,769	16,380	17,195	14,417	9,181	8,747	8,673
	%ch		5.1	-2.3	5.0	-16.2		-4.7	-0.8
Shipments	$m	936.5	1,134.0	1,334.5	1,521.2	1,391.0	828.1	841.4	945.2
	%ch		21.1	17.7	14.0	-8.6		1.6	12.3
Industry Selling Price Index	1981=100	70.6	81.5	90.1	100.0	107.5	107.5	114.3	119.5
	%ch		15.5	10.6	10.9	7.5		6.4	4.5
Real Shipments	1981$m	1,326.8	1,391.1	1,480.5	1,521.2	1,294.4	770.6	736.0	790.9
	%ch		4.8	6.4	2.7	-14.9		-4.5	7.5
Real Shipments per Employee	1981$000's	83.2	83.0	90.4	88.5	89.8	83.9	84.1	91.2
	%ch		-0.3	9.0	-2.1	1.5		0.2	8.4

Scientific Instruments		1978	1979	1980	1981	1982	1982	1983	1984
			(1970 SIC 3911)				(1980 SIC 3911)		
Establishments	number	183	210	214	242	257	169	194	227
Employment	number	13,491	14,601	15,081	16,197	16,594	10,477	11,823	11,640
	%ch		8.2	3.3	7.4	2.5		12.8	-1.5
Shipments	$m	791.5	942.7	1,129.4	1,300.8	1,382.7	552.8	614.0	706.0
	%ch		19.1	19.8	15.2	6.3		11.1	15.0
Industry Selling Price Index	1981=100	73.9	83.0	90.8	100.0	108.2	108.2	109.6	110.3
	%ch		12.4	9.4	10.2	8.2		1.3	0.6
Real Shipments	1981$m	1,071.7	1,135.9	1,244.3	1,300.8	1,277.7	510.8	560.0	639.9
	%ch		6.0	9.5	4.5	-1.8		9.6	14.3
Real Shipments per Employee	1981$000's	79.4	77.8	82.5	80.3	77.0	48.8	47.4	55.0
	%ch		-2.1	6.1	-2.7	-4.1		-2.9	16.1

Note: 1980 SIC redefinition moved a number of establishments into other sectors. The most notable changes are in SICs 333, 339 and 3911.
Source: Statistics Canada, Census of Manufacturers.

APPENDIX III

TRENDS IN EMPLOYMENT BY OCCUPATION

There are a number of comments to be made regarding the yearly breakdown of employment by occupation presented in Table III.1. The data in the table were calculated from the survey results, and should be interpreted with care. In many instances, companies did not report a complete time series of employment levels. There were often no values given for the earliest year (1981) or the forecast years (1987,1988). As a result, the data in Table III.1 are presented in the form of employment shares, rather than reported levels, to indicate occupational trends.

The sum of the occupational estimates fluctuates between 40,500 and 45,000 between 1981 and 1988. These sums are below the total of 51,777 reported in Appendix I, as not all respondents completed the occupational breakdown portion of the questionnaire.

Several of the occupations with low employment levels were aggregated into their job families when these shares were being calculated. Examples of these were machine operators, sheet metal workers and occupations in quality control. In other instances, occupations such as those in engineering were left at a disaggregated level for illustrative purposes even though their relative share of employment is small.

A good example of the need for caution when interpreting the results can be seen by observing the trend in the share of technologists and technicians. For 1981, 1985 and 1986, this occupational group accounts for a significant share of total employment. However, there is a sharp drop in the share after 1986. It is likely that this decline is due to a few relatively large employers being unable to report their anticipated employment levels, rather than to a dramatic shift in the employment distribution. It is reasonable to deduce, however, that a decline in the share between 1981 and 1985 could have been caused by the 1981-82 recession.

Another area where unreported data may be an influence is in the 'Computer Programmers/Systems Analyst' occupation. There was a 1 percent increase in the share between 1981 and 1985. It remains virtually the same in 1986, but falls sharply in 1987 and 1988. Investigation of the results indicates that this is due in part to a discontinuous time series reported by some respondents and in part to a projected decline in requirements for these occupations. Other areas of the study have also indicated that the strong growth in systems analyst positions experienced in the past few years will not continue at the same rate over the next few years.

It is clear that the 'Assembler' category captures the largest share of employment in the industry. These are assemblers with at least six months training. There was a decline in the share between 1981 and 1985, however it is expected to remain constant over the 1987-88 period. A majority of the 'Jobs requiring less than one month of training' are lesser-skilled assembly positions. This category accounts for a relatively large share as well, however, it is rising over time. These two groups combine to show that assembly will continue to account for a significant proportion of employment in the electrical and electronics industry.

The next largest category after assemblers is 'Managers and other administration'. This group includes all types of supervisory occupations ranging from line foremen to chief executive officers. This group is expected to show a slight increase in its share of total employment from 1986 to 1988.

'After-sales service' occupations account for a significant component of employment, with a rising trend over time. This is consistent with other findings in the study which indicate that manufacturers are placing more emphasis on sales, service and repair activity.

'Machine operators' is an occupation that traditionally, like assemblers, has been expected to decline in importance as new technologies are adopted. However, the survey results show an increasing trend through 1987.

In the office-related occupations, it appears that there are nearly three times as many senior clerks as there are intermediate. The shares of total employment for all clerks is reported to be constant over time.

Most of the specific engineering disciplines have shares of total employment that are less than 1 percent, but are presented at the detailed level for illustrative purposes. The number of electrical engineers grew at an annual rate of 8.5 percent between 1981 and 1986, while the numbers of electronics engineers grew at an 11.5 percent annual rate. The relative share of electronics engineers continues to increase in 1987 and 1988 while the electrical engineering share starts to fall, possibly due to the expected introduction of electronics-based rather than electrical technologies.

The decrease after 1986 in the share of employment in the 'Draftsperson' group is partially offset by an increase in the share of 'CAD/CAM operators'. This is to be expected based on findings that CAD is relatively widely adopted in this industry and that it appears to be becoming subsumed into other engineering and technologists/technician occupations.

Table III.1

Shares of Total Employment by Occupation
(Percentages)

	1981	1985	1986	1987	1988
Jobs requiring less than one month of training	8.8	9.3	9.6	10.0	10.2
Assemblers	31.8	26.6	24.7	27.1	26.7
Machine operators	3.2	3.7	3.9	4.2	4.2
Sheet metal workers	0.9	1.1	1.1	1.1	1.2
Foundry-mould makers	0.07	0.06	0.04	0.02	0.02
Computer programmers/ Systems analysts	1.3	2.3	2.4	0.8	0.8
Other computer operators	0.6	0.6	0.7	0.7	0.7
Wood processing/typists	0.3	0.4	0.5	0.4	0.4
Intermediate clerks	2.5	2.1	2.2	2.3	2.3
Senior clerks	6.2	7.6	7.3	7.6	7.4
Secretaries	1.0	1.6	1.7	1.4	1.3
Managers and other administration	16.0	15.7	15.6	16.5	16.6
Financial	0.8	0.9	0.9	0.9	0.9
Material movement	2.3	2.5	2.6	2.6	2.5
Maintenance	2.1	1.7	1.8	1.7	1.7
Quality control	1.7	1.5	1.7	1.7	1.8
Tool & die makers	0.4	0.2	0.2	0.2	0.2
Other tool room	0.03	0.01	0.03	0.03	0.03
Technical sales rep.	1.6	1.5	1.6	1.7	1.8
Non-tech. sales rep.	1.8	2.3	2.4	2.6	2.6
Other sales reps.	0.3	0.6	0.7	0.6	0.6
Computer engineers	0.2	0.3	0.4	0.3	0.4
Communications engineers	0.04	0.11	0.16	0.22	0.23
Control systems engineers	0.3	0.3	0.3	0.3	0.3
Electrical engineers	0.22	0.32	0.33	0.25	0.26
Electronic engineers	0.6	0.9	1.0	1.0	1.1
Mechanical engineers	0.2	0.3	0.3	0.3	0.3
Draftsperson	0.7	0.7	0.9	0.7	0.7
Specification writer	0.06	0.01	0.12	0.11	0.11
CAD/CAM operator	0.04	0.07	0.10	0.14	0.16
Systems engineer	0.07	0.1	0.11	0.12	0.12
Industrial engineer	0.02	0.06	0.07	0.09	0.10
Manufacturing engineer	0.12	0.1	0.11	0.13	0.14
Other engineers	2.5	3.3	3.6	3.8	3.8
R&D engineers	0.08	0.13	0.14	0.17	0.21
R&D technicians/ technologists	0.27	0.25	0.35	0.28	0.29
Other R&D	0.07	0.08	0.09	0.10	0.10
After-sales service	4.0	4.7	4.9	5.5	5.4
Technicians/technologists	5.1	4.2	4.1	0.6	0.6

APPENDIX IV

POST-SECONDARY SCHOOL GRADUATE TRENDS FOR ELECTRICAL ENGINEERS AND ELECTRICAL TECHNOLOGISTS/TECHNICIANS

Selected results from the 1984 National Graduate Survey (NGS) and the COPS Student Flow Model are presented in this section. The NGS looks at the employment status of graduates two years after leaving school, including data on employment by occupation and by industry. The COPS model separates graduates by field of study and the type of degree or diploma earned. The data are projected to 1992 using the historical shares of the latest year available, which in this case is 1983.

The data in Tables IV.1 and IV.2 focus on the share and number of electrical engineering or technologists/technician graduates relative to the total number of post-secondary graduates in Canada. The table illustrates, with few exceptions, that the proportion of graduates in the engineering fields has risen steadily since 1977. This upward trend is also apparent when considering the corresponding number of graduates.

Table IV.3 shows the distribution by industry where 1982 engineering graduates were at work in 1984. These industries were typically communications equipment, electric utilities and engineering services. Almost one-half of those with doctorates were employed at universities.

The occupational breakdown of electrical engineering and technologist/technician graduates, by type of degree or diploma is presented in Table IV.4. The distribution shows that the majority of engineering graduates with Bachelor or Masters degrees in 1984 were employed in the natural sciences, engineering or mathematics fields. A significant 29.1 percent of college graduates were employed in these fields as well. A larger 32.5 percent share of college graduates, however, were employed in the product fabricating, assembly and repair occupations. An indication of the increase in the use of electronic technologies can be seen by the fact that 10.7 percent of these college graduates were employed in electronic installation and repair in 1984, which is double the proportion for those installing and repairing electrical equipment.

Table IV.1

Electrical Engineering and Technologist/Technicians Graduates as a Share of Total Canadian Graduates by Type of Degree or Diploma (Percent)

	1977	1979	1981	1983
Bachelor Degrees				
Electrical engineers	1.1	1.5	1.7	1.8
All Engineers	5.0	6.5	7.3	7.5
Masters Degrees				
Electrical engineers	2.0	2.0	1.7	1.8
All engineers	8.3	8.5	7.2	8.5
Doctorates				
Electrical engineers	3.4	3.1	3.8	2.8
All engineers	11.6	12.2	12.1	11.3
Total University Graduates				
Electrical engineers	1.3	1.5	1.6	1.7
All engineers	5.4	6.5	7.0	7.3
Community College Career Program Graduates				
Electrical tech.	5.5	6.0	6.0	6.2
All tech.	19.6	21.2	21.3	21.7

Table IV.2

Annual Number of Canadian Electrical Engineering and Technologist/Technician Graduates by Type of Degree or Diploma

	1977	1979	1981	1983
Bachelor Degrees				
Electrical engineers	958	1,323	1,430	1,602
All Engineers	4,356	5,618	6,180	6,689
Masters Degrees				
Electrical engineers	252	244	223	245
All engineers	1,025	1,048	928	1,184
Doctorates				
Electrical engineers	58	55	69	50
All engineers	197	219	219	206
Total University Graduates				
Electrical engineers	1,407	1,735	1,843	2,087
All engineers	6,002	7,467	8,054	8,918
Community College Career Program Graduates				
Electrical tech.	2,036	2,569	2,805	3,157
All tech.	7,320	9,077	10,010	11,023

Source: C.O.P.S. Student Flow Model, Employment and Immigration Canada

Table IV.3

1984 Distribution by Industry of 1982 Graduates in Electrical Engineering and College Programs by Type of Degree or Diploma (Percent)

	Bachelor	Masters	Doctorate	College
Electrical & electronics	21.9	25.1		13.7
Other manufacturing	17.0	10.9		13.5
Construction				4.0
Transportation & storage				2.5
Communications				9.6
Electric power systems	10.1	10.6		5.2
Other utilities	12.5	5.5		0.4
Wholesale trade				12.9
Retail trade				5.7
Computer services				2.9
Engineering services	14.0	14.0	25.7	4.0
Other business services	5.7	6.2		1.5
Protective services		9.7		5.7
Other government services		7.3		2.8
Education			46.9	4.1
Health and social services				2.1
Other	18.8	10.7	27.4	9.4
Total	100.0	100.0	100.0	100.0

Table IV.4

1984 Distribution by Occupation of 1982 Graduates in Electrical Engineering and College Programs by Type of Degree or Diploma

	Bachelor	Masters	Doctorate	College
Management			21.4	5.8
Arts				2.9
Clerical				3.2
Sales				5.0
Service				2.0
Construction trades				7.8
Teaching			46.9	
Electrical engineers	48.2	50.6	27.1	3.9
Other engineers	4.6	2.0		1.1
Draughtsmen				2.7
Technologist/Technicians				18.8
Other technical		8.4		
System analysts/programmers	9.2	14.1		
Natural sciences, mathematics	10.6	8.0	4.6	2.7
Electrical/electronic installation, assembly, fabr. and repair				22.8
Mechanics and Repairmen				8.0
Non-electrical installation, assembly, fabr. and repair	9.6			1.7
Other	17.8	16.9		11.6
Total	100.0	100.0	100.0	100.0

Source: 1984 National Graduate Survey of 1982 Graduates, Statistics Canada

APPENDIX V

DURATION OF UNEMPLOYMENT BY REGION

The following data covers the regions in Canada other than Ontario, which can be found in Chapter 6, Table 6.1, page 94.

Distribution of the Duration of the First Spell of Unemployment After Permanent Separation from the Electrical/Electronics Sector by Age Group

ATLANTIC

Duration of Unemployment (weeks)	All Individuals (percent)	Age Group 20	20-29	30-39	40-49	50+
			(percent)			
5	14	12	13	13	9	21
5-12	16	16	16	18	13	16
13-25	16	18	16	18	12	11
26-50	31	32	32	28	37	23
51+	23	22	23	22	29	29

QUEBEC

Duration of Unemployment (weeks)	All Individuals (percent)	Age Group 20	20-29	30-39	40-49	50+
			(percent)			
5	16	15	17	15	17	13
5-12	17	15	18	18	16	17
13-25	22	25	23	19	17	19
26-50	28	30	26	30	26	26
51+	17	15	16	18	24	25

WEST

Duration of Unemployment (weeks)	All Individuals (percent)	Age Group 20	20-29	30-39	40-49	50+
			(percent)			
5	18	16	19	19	19	14
5-12	19	19	20	20	17	20
13-25	23	25	24	19	24	24
26-50	25	25	22	26	24	26
51+	15	15	15	15	15	16

APPENDIX VI

MEMBERS OF THE STEERING COMMITTEE

The following is a list of individuals who were major contributors throughout the bulk of the study.

Steering Committee Members

Mr. Barry Foster, Chairman, Employee Relations Committee, Electrical and Electronic Manufacturers Association of Canada; Vice President, Employee Relations, RCA Inc.
Mr. Glenn Pattinson, Division Vice-President, Communications and Electrical Workers of Canada
Mr. William Scrafton, Personnel Manager, Johnson Controls Ltd.
Mr. Ken Woods, International Representative, International Brotherhood of Electrical Workers

Woods Gordon Management Consultants

Mr. Roger Briers, Partner
Mr. Greg Young, Senior Consultant
Mr. Ted Mallett, Consultant

Employment and Immigration Canada

Mr. Derwyn Sangster, Director General, Labour Market Outlook and Structural Analysis
Mr. Gary Fletcher, Director, Research and Special Studies
Miss Debbi Craniford, Sector Analyst, Research and Special Studies

The following is a list of other individuals whose contribution has also been invaluable during the progress of the study.

Steering Committee Members

Mr. H.D. Barber, Linear Technology Inc.
Mr. Harold Giles, Canadian General Electric Co. Ltd.
Mr. Dennis Hall, Coopers and Lybrand Consulting Group
Mr. James Kennedy, Canadian Automotive Workers
Ms. Katherine McGuire, Communications and Electrical Workers of Canada
Mr. Milt Pogson, Northern Telecom Canada Ltd.
Mr. John Rankin, Northern Telecom Canada Ltd.
Mr. Robert Webb, Westinghouse Consulting and Development Group
Ms. Alda Murphy, Electrical and Electronic Manufacturers Association of Canada

Employment and Immigration Canada

Ms. Nicole D'Avignon
Mrs. Monique Leclerc
Mr. André Loranger
Mr. Ashwin Shingadia